No. 12885

IN THE

United States Court of Appeals

FOR THE NINTH CIRCUIT

CONSOLIDATED VULTEE AIRCRAFT CORPORATION, a Delaware corporation, and AMERICAN AIRLINES, INC., a Delaware corporation,

Appellants,

vs.

MAURICE A. GARBELL, INC., a California corporation, and GARBELL RESEARCH FOUNDATION, a California corporation,

Appellees.

OPENING BRIEF OF APPELLANTS.

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Consolidated Vultee Aircraft Corporation, a Delaware corporation, and American Airlines, Inc., a Delaware corporation,

Appellants,

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Maurice A. Garbell, Inc., a California corporation, and Garbell Research Foundation, a California corporation,

Appellees.

OPENING BRIEF OF APPELLANTS.

I.

Statement of Jurisdiction.

Jurisdiction of the District Court in this action is founded upon the patent statutes of the United States [Complaint, R. 4], and this is admitted by the defendants [Answer, R. 6]. The District Court's judgment was entered on January 15, 1951 [R. 58], and appellants' notice of appeal was filed on February 12, 1951 [R. 134]. Jurisdiction of the District Court is therefore founded upon Title 28, Section 1338, of the United States Code, and jurisdiction of this Court of Appeals is founded upon Title 28, Section 1292(4) of the United States Code.

II.

Statement of the Case.

A. The Parties. Defendant-appellant Consolidated Vultee Aircraft Corporation (hereinafter referred to as "Consolidated") is a Delaware corporation, having its principal place of business at San Diego, California. It is, and for many years has been, engaged in the development, design, and manufacture of commercial and military aircraft.

Defendant-appellant American Airlines, Inc. (hereinafter referred to as "American") is a Delaware corporation, which for many years has been engaged in the commercial operation of aircraft for passenger and freight transportation.

Plaintiffs-appellees Maurice A. Garbell, Inc., and Garbell Research Foundation (hereinafter collectively referred to as "plaintiffs") are California corporations, being assignees by mesne assignments of Letters Patent No. 2,441,758 in suit. Maurice A. Garbell, patentee of the patent in suit and plaintiffs' sole witness, is the president of both plaintiffs.

B. The Issue. The Complaint charges infringement of claims 1, 2, 3, 5, 6, and 12 of U. S. Patent No. 2,441,-758, issued on May 18, 1948, to Maurice A. Garbell on "Fluid-Foil Lifting Surface," generally known as an aircraft wing. Consolidated is charged as a maker of the aircraft wing used on its Model 240 "Convair" airplane, and American is charged as a user of such aircraft, in infringement of the patent in suit.

The District Court held the Garbell patent No. 2,441,-758 in suit valid, and held that the wings of the Model 240 "Convair" airplanes sold by Consolidated and used by American infringe the patent in suit [R. 58-59]. Consolidated has sold about 170 of such "Convair" airplanes, the selling price thereof ranging from $260,000.00 to $560,000.00 each. The judgment of the District Court, if sustained, has important and far-reaching effects and restraint upon the aviation industry.

The District Court enjoined further manufacture, use, and sale by defendants of such aircraft [R. 59-64], but upon the posting by defendants of a $50,000.00 bond, the issuance of the injunction was stayed pending appeal [R. 135-136]. A motion for a new trial brought by defendants [R. 65] was denied by the District Court.

C. Background of the Patent in Suit. Garbell, the patentee, was born in Moscow, Russia, in 1914 [R. 158]. His early personal background is set forth in detail in Plaintiffs' Exhibit 15 [R. 624-632]. In Italy, Garbell became interested in making and flying sailplanes (*i. e.,* "gliders"), and for several years up until 1938, he engaged in the design and flight of such sailplanes [R. 159-162], in 1937 taking part in building and publicly flying a sailplane known as the "Pinguino," which, he testified, embodied the "principles" of the alleged invention of the patent in suit [R. 239-241].

In 1939, Garbell came to the United States by slow boat, and, he asserts, it was during this boat trip that he conceived the alleged invention of the patent in suit [R. 164-165, 199]. Plaintiffs produced no corroboration of any kind of Garbell's story of such conception, and only his naked, oral testimony lends it any support.

From his arrival in the United States until August, 1942, Garbell was employed in various occupations, most of which related to aviation [R. 631]. During this period, Garbell did nothing with regard to the alleged invention of the patent in suit. He testified that he disclosed the conception to a Harry Bradford Chin and to a Dr. Platt [R. 199-207], but neither was called as a witness by plaintiffs to corroborate Garbell's testimony. In fact, Platt had died and Chin by affidavit, produced on defendants' motion for a new trial, denied Garbell's assertions [R. 66].

In July, 1942, Garbell applied to Consolidated for a job as an aeronautical engineer, representing that he was "well versed in airplane and engine design, performance analysis and research," and stating: "I am primarily interested in being placed where my ability may find its greatest usefulness in your organization, namely preliminary design or research engineering" [R. 617-624]. In the negotiations for such employment, Garbell set forth at length his qualifications and his previous extensive and varied experience in aircraft design [R. 617-624]. If Garbell, prior to his employment by Consolidated, had actually conceived such alleged invention, he kept it to himself and made no claim or assertion with regard thereto to the defendant, although he was obviously attempting to impress Consolidated with his past accomplishments.

Garbell was hired by Consolidated on September 7, 1942, by a formal employment agreement [Pltfs. Ex. 15, R. 624], as an "Aeronautical Engineer" [R. 802], with duties which included designing, planning, and analysis of a wide field of aerodynamic subjects, including aircraft wings [R. 694-774]. As early as March, 1944, he was made a "Group Engineer," a supervisory position directing a group of engineers whose duties included the design and geometry of new airfoils, wings, and tails, and work on the stalling characteristics of airplanes [R. 296-297, 800-801].

Obviously, from the foregoing, Garbell was hired and paid for creating, developing, and perfecting airfoil designs for Consolidated.

Concurrently with his original employment, Garbell executed a standard form of Invention Agreement [R. 633], the pertinent provisions of which are as follows:

> "1. The Employee agrees:
>
> (a) To disclose promptly in writing to the Company's Patent Department or to such person as the Company may designate, all inventions and improvements heretofore or hereafter made, developed, perfected, devised or conceived by the Employee either solely or in collaboration with others during the Employee's employment by the Company, whether or not during regular working hours, and including a period of one (1) year after termination of employment, relating to aircraft or parts and the manufacture thereof, or relating in any way to aviation or to the business, developments or products of the Company; and if so requested by the Company, to assign, transfer and convey to the Company all right, title and interest in and to all such inventions and improvements;
>
> * * * * * * * *
>
> "6. If the Company shall fail to elect in writing that it desires to prosecute a patent application on any invention or improvement specified in paragraph 1 hereof within nine months following the complete disclosure thereof to the Company, then all rights of the Company in and to such invention or improvement

shall revert to the Employee with the exception only that the Company shall have a free shop right with respect thereto. . . ."

The earliest evidence relating to the conception of the alleged invention of the patent in suit (other than Garbell's uncorroborated oral testimony) occurs in connection with an airplane known as the "Two-Engine Tailless Design," which was being designed by Consolidated in 1943 and 1944. Early in 1944, Garbell was working with two other Consolidated engineers, Fiul and Rogers, on the "Two-Engine Tailless Design" [R. 250, 294-296]. On February 25, 1944, the three of them submitted a joint report [Defts. Ex. A, R. 1007], which Garbell admitted at the trial embodied the wing construction of the patent in suit, and which recommended the use of such conception by Consolidated in its "Two-Engine Tailless" airplane being designed [R. 244-250, 303]. As will be noted, the report was "approved" by Mr. T. P. Hall on page 1 thereof. Mr. Hall was chief development engineer of Consolidated at that time.

Consolidated built a wind-tunnel model of the "Two-Engine Tailless," which incorporated the conception of the patent in suit [R. 308], and the last model made of this proposed airplane has such wing construction [R. 322]. Garbell and his engineering group analyzed the results of wind-tunnel tests of models of the airplane [R. 257, 294-295]. A series of Consolidated wind-tunnel tests and reports by Garbell thereon are detailed in the evidence [R. 735, 745, 755, 758, 759].

Additionally, Garbell recommended to Consolidated that the wing idea here in suit be used: In its Model 107 "Executive Transport" airplane; in its Model XB-46 bomber [R. 251-255]; and in its Model 110 transport [R. 275, 466-467].

Garbell, in his report dated March 2, 1945, Plaintiffs' Exhibit 25 [R. 666], plainly indicated that his alleged invention had, prior to that date, been successfully applied to the Tailless Design [Model 101], the executive transport [Model 107], and the XB-46 design, and "yields several satisfactory wings."

Garbell admits that he proposed to his employer Consolidated that it use his alleged invention of the patent in suit in its *XB-46* bomber, that the invention was incorporated in the plans for the bomber, and was incorporated in the prototype XB-46 airplane actually built by Consolidated in accordance with such plans [R. 251-256]. Garbell, on behalf of Consolidated, in May, 1945, had extensive conferences with N. A. C. A. representatives relative to the proposed XB-46, its design, and its further extensive testing, as is shown by his written report to defendant dated May 10, 1945 [R. 760-774].

Finally, Garbell admitted that he suggested that defendant Consolidated use in its proposed *Model 110* airplane the same wing construction principles that he had recommended for the "Two-Engine Tailless" design (*i. e.,* the alleged invention of the patent in suit) [R. 466-468]. The preliminary design work on the *Model 110* was initiated prior to the end of the war by Consolidated (*i. e.,* while Garbell was still employed by it), and it incorporated the three-control wing sections suggested by Garbell [R. 416-417]. The same wing sections were used by defendant in the Model 240 "Convair" here in suit [R. 418]. Such proposed design was incorporated in an actual *Model 110* airplane that was built and extensively tested by Consolidated. It is significant in this connection that defendant's flight tests, Plaintiffs' Exhibit 35, upon which Garbell relied in attempting to show infringement by the Model 240 "Convair" [R. 442-444], include earlier flight tests of the *Model 110.*

From the foregoing, it is clear that Garbell while employed by defendant Consolidated and in the line of his employment, proposed that the alleged invention of the patent in suit be incorporated in at least four aircraft being designed by it, that such suggestions were approved and adopted and included in the design of such aircraft, that models of such aircraft were built and extensive wind-tunnel tests conducted thereon by Consolidated, and that in due course thereafter actual aircraft of the *XB-46* and *Model 110* types were built and extensively tested by defendant Consolidated.

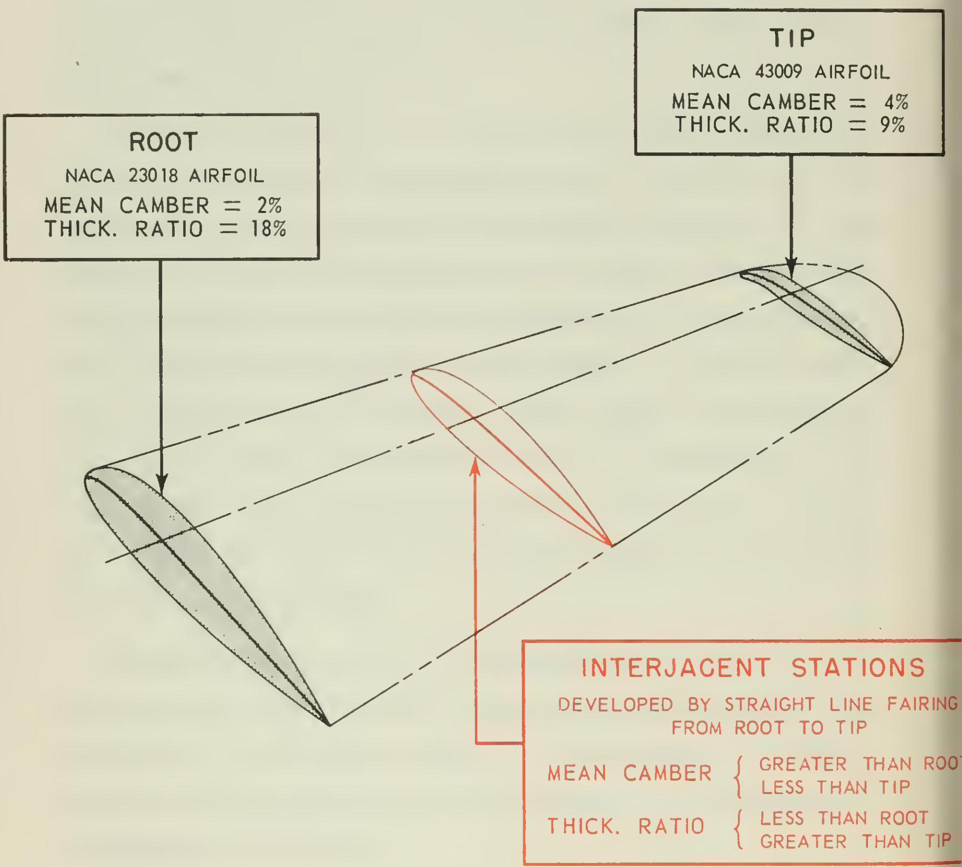
Garbell testified that the wind-tunnel tests referred to in his patent in suit [R. 612] were those conducted by Consolidated in connection with its "Two-Engine Tailless" and its XB-46 aircraft, and were all done at the expense of defendant [R. 260-265].

At no time up to October 15, 1945, when he terminated his employment with Consolidated, had Garbell ever made any claim adverse to the use by Consolidated of the alleged invention of the patent in suit. To the contrary, during his employment by the defendant, Garbell at every opportunity suggested that Consolidated use the idea and encouraged its use, and, moreover, was active in his em-

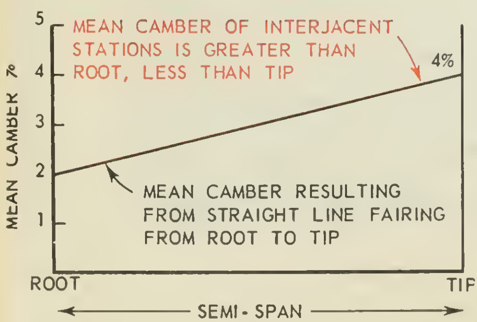
CONVENTIONAL WING

DESIGNED TO AVOID TIP STALL

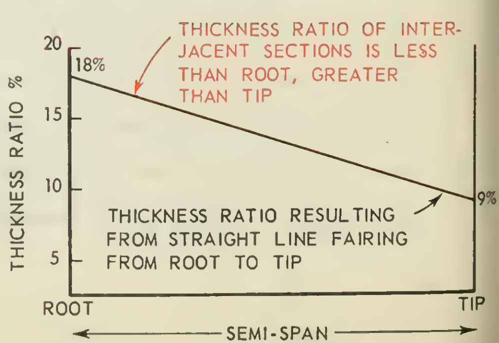
EXAMPLE TAKEN FROM PAGE 516, FIG. 6 – DEF. EXH. XXX



SPANWISE DISTRIBUTION OF MEAN CAMBER



SPANWISE DISTRIBUTION OF THICKNESS RATIO



CONVENTIONAL AIRPLANE NOMENCLATURE

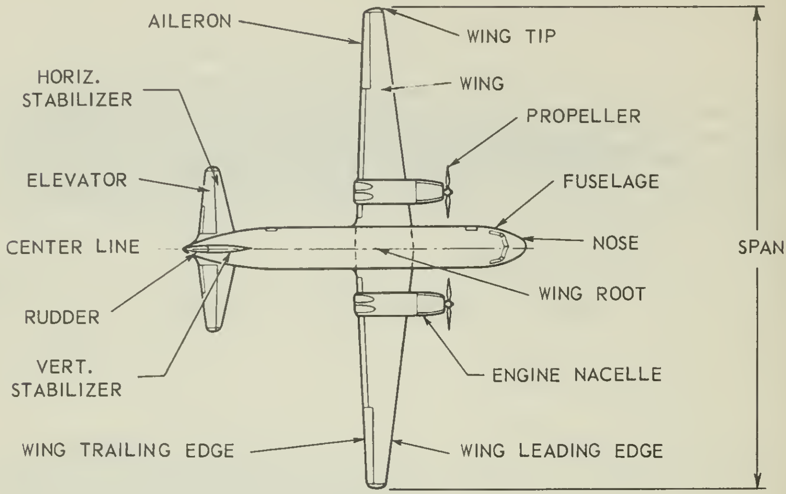


FIG. 1

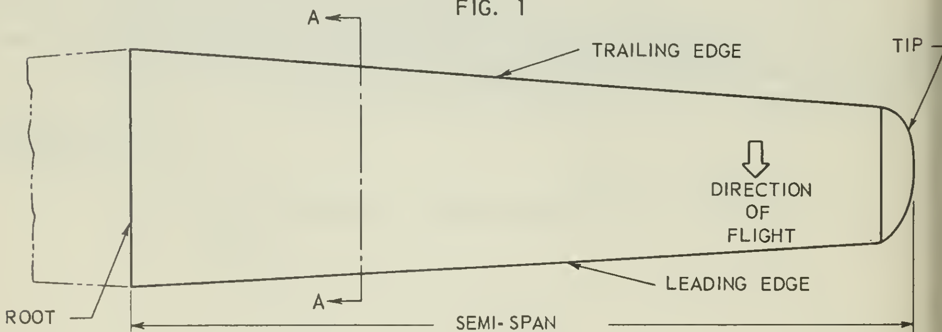


FIG. 2 - PLANFORM OF WING

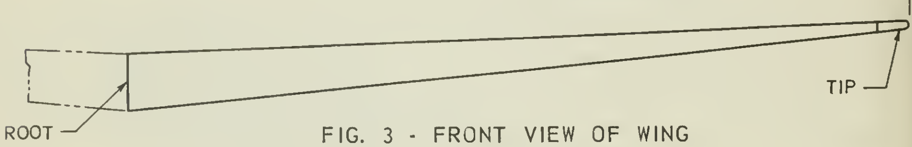


FIG. 3 - FRONT VIEW OF WING

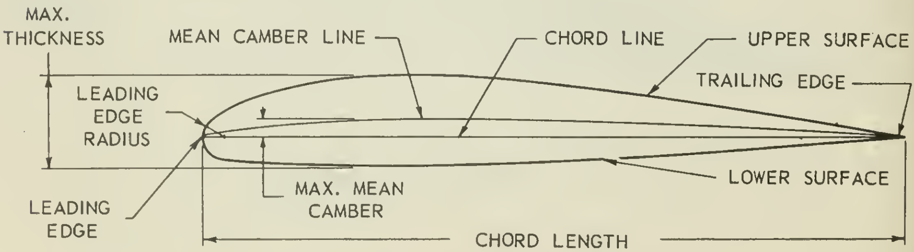


FIG. 4 - AIRFOIL SECTION A-A

ployment duties in supplying designs, supervising, and analyzing wind-tunnel tests on models incorporating the idea.

Garbell's application for the patent in suit was filed on July 16, 1946, less than one year after he left Consolidated.

D. A Conventional Aircraft Wing. The aircraft art has developed and standardized its own lexicon of terms, which are used in the patent in suit and the evidence. Many of these are explained and defined in "Appendix A," and are illustrated by Plates I and II, following this page. Since the patent in suit relates to the geometry of an aircraft wing, it is first desirable to explain the geometry of a conventional wing.

It is conventional in the art to provide a tapered aircraft wing in which the root section has the smallest mean-line camber and the greatest thickness ratio, and the tip section has the greatest mean-line camber and the smallest thickness ratio, with straight-line or lineal fairing between the root and the tip. Such a conventional wing is fully described in Defendants' Exhibits UU and XXX, and is graphically illustrated by Plate III, following Plate II.

In such a conventional wing there are an infinite number of interjacent sections between the root section and the tip section, each of which has a mean-line camber that is greater than that of the root section and less than that of the tip section, and which has a thickness ratio which is less than that of the root section and greater than that of the tip section. This, also, is plainly illustrated in Plate III.

The purpose of such construction in the conventional wing is to suppress stall at the tip of the wing and to cause the stall to initiate and to develop at an area inboard of the tip.

E. The Patent in Suit. The patent in suit likewise describes and claims a wing in which the root section has the smallest mean-line camber and the greatest thickness ratio, the tip section has the greatest mean-line camber and the smallest thickness ratio, and having one or more interjacent sections between the root and the tip having a mean-line camber greater than that of the root section and less than that of the tip section and which have a thickness ratio less than that of the root section and greater than that of the tip section. The primary object of the patent in suit is likewise to suppress stall at the tip and to cause the stall to initiate and develop at an area inboard of the tip. Up to this point, *the wing of the patent in suit is identical with the conventional wing.*

The only structural differences between the wing of the patent in suit and the conventional wing is that in the wing of the patent in suit the fairing between root and tip is not straight-line or lineal fairing but is non-lineal, this being accomplished by providing one or more interjacent sections between root and tip, each of which has a mean-line camber *at variance with* (claims 2 and 3) or *greater than* (claim 1) that obtainable at such section by conventional straight-line fairing, or which has a thickness ratio *at variance with* (claims 5 and 6) or *less than* (claim 12) that obtainable by such straight-line fairing.

Neither the claims nor the specification of the patent in suit indicate the required extent of such "variance," although the specification teaches that the mean-line camber of the interjacent section shall "neither *exceed* the mean-line camber of the tip section nor *fall below* the mean-line camber of the root section" [Col. 4, lines 53-55], and that it may have "a value *equal to or slightly less* than" "that of the tip section" [Col. 7, lines 66-71].

In the patent in suit, the "interjacent control section" is located at either 55% or 60% of the semi-span from root to tip [Col. 8, lines 45-48; Col. 9, lines 1-9].

Stall inception and progression of the wing of the patent in suit are illustrated in Figure 3 thereof, which shows that "the stall inception occurs near mid-semi-span, spreads more prevalently inboardward and to a smaller extent outboardward" [Col. 5, lines 7-9]. Garbell testified that such stall inception should occur outboard of the tail of the aircraft [R. 183], and his "official disclosure of invention" to Consolidated similarly locates the stall inception [R. 780].

Garbell conceded that wings having stall inception inboardly of the tip at the mid-span and spreading laterally across the wing [R. 176-177], and wings having stall inception at the root and spreading outboardly therefrom [R. 178-182], were old in the art before his alleged invention, and were not covered by his patent in suit.

F. Defendants' Accused Wing. This wing is embodied in an airplane designated by Consolidated as its Model 240 "Convair," which was an outgrowth of its earlier Model 110. Its construction is fully shown in the exhibits, and has an interjacent section located only 30.7% of the semi-span from root to tip [R. 1000-1005]. Such interjacent section has a mean-line camber greater than that of the root and less than that of the tip, and a thickness ratio less than that of the root and greater than that of the tip. The Model 240 wing has engine nacelles, twist, and fillets, all of which, the engineers agree, influence the over-all stall characteristics of defendants' wing.

The uncontroverted testimony of the witness Ward, a Consolidated aerodynamicist [R. 412] fully familiar with the Model 240 airplane and its flight tests, was that its stall initiated between the nacelle and the fuselage and was a "root stall" [R. 416, 419]. This, and the fact that such stall progresses only outboardly from the root, is confirmed by the affidavits of the engineers Matteson [R. 89] and Fox [R. 123] and the test report on the Model 240 [R. 113, 121]. In defendants' wing, there is no progression of the stall inboardly at any time. It is all outboard.

III.

Specifications of Error in the Findings of the District Court.

1. That the patent teaches an original or any method of aircraft wing construction having a stall which has its inception over a large area inboard of the lateral control surface and which spreads inboard and that the result is a special stall characteristic [F. VIII, R. 45], is erroneous because contrary to the patent, and unsupported by and contrary to the evidence; erred in failing to find that such stall has its inception over a relatively small area outboard of the aircraft tail and which spreads both inboardward and outboardward.

2. That the patent solved any problem in aircraft wing construction by the wing described in said findings [F. VIII, IX, X, R. 45-47], *are* erroneous because unsupported by and contrary to the evidence, and in not finding that such wing construction was old and said problem had been solved in the art long prior to the patent.

3. That the patent solved any stall problem in aircraft in producing a stall characteristic as described therein [F. XI, XII, R. 47], *are* erroneous because contrary to and unsupported by the evidence, and failing to find that such a stall characteristic had been achieved in the art long prior to the patent in suit.

4. That upon the disclosure of the alleged invention of the patent to defendant Consolidated, the same was rejected by it [F. XIII, R. 48] is error because contrary to the evidence.

5. That the patent has a principle of operation unknown to the art prior thereto [F. XIV, R. 48], is error because there is no evidence to support it, is contrary to

the evidence, and in not finding that such principle of operation was old in the art long prior thereto.

6. That the prior art does not disclose any knowledge, use, or development of a wing which would operate upon the principle or which would produce the result of that of the patent [F. XV, R. 48], is erroneous as contrary to the evidence which shows that that result was old in the art.

7. That any invention was involved in the patent [F. XVI, R. 48] is error because unsupported by and contrary to the evidence, which shows that the combinations defined in each of claims 1, 2, 3, 5, 6 and 12 in suit lack invention and differ only in degree.

8. That the combination of the claims in suit was novel [F. XVII, R. 48] is erroneous because the claims are anticipated by the art; and in not finding that all of such claims are devoid of novelty over the prior art.

9. That defendants have not sustained the burden of proof in establishing prior manufacture, use, sale, and knowledge of the alleged invention of the patent [F. XVIII, R. 49] is erroneous, contrary to the evidence; and in failing to find that defendants have sustained such burden.

10. That the structures relied upon by defendants in the aircraft referred to by defendants' witnesses do not incorporate, describe, or show prior knowledge of a wing having a mode of operation or producing the result of that of the patent in suit as described [F. XIX, R. 49] is error, being contrary to the evidence.

11. That none of the prior-art references relied upon by defendants suggests or teaches the desirability of inducing an initial stall over a wide area of an interjacent

section so that the stall will proceed inboardly toward the root [F. XX, R. 49], is error, being contrary to the evidence.

12. That the prior art does not teach or disclose knowledge of a wing having the stall characteristics set forth in the patent in suit [F. XXI, R. 50] is erroneous as not supported by and contrary to the evidence.

13. That the claims in suit point out or distinctly claim the alleged invention [F. XXII, R. 50], is error because unsupported by the evidence, and erred in failing to find that such claims fail to meet the requirements of Title 35, U. S. C. A., Section 33.

14. That the invention of the patent advanced the scientific knowledge of the art [F. XXIII, R. 50], is error because unsupported by and contrary to the evidence.

15. That the alleged invention of the patent was not obvious to those skilled in the art [F. XXIV, R. 50] is erroneous; and erred in not finding that the evidence shows the alleged invention was obvious to those skilled in the art prior to Garbell's alleged invention thereof.

16. Findings XXV, XXVI, and XXX, and Conclusions III and IV [R. 51, 52, 56-57] are erroneous in finding that the Convair Liner, Model 240, infringes the claims in suit, because they are not supported by and are contrary to the evidence.

17. That the specification of the patent is in clear, concise, and exact terms sufficient to enable any person to make or use the same, and that it sets forth the principle of the alleged invention and the best mode of applying such principle [F. XXIX, R. 52], is erroneous because contrary to law and unsupported by the evidence.

18. That no evidence was offered on behalf of defendants to controvert plaintiffs' proof of infringement or to show the absence of infringement and departure of the accused device from the teachings of the patent in suit [F. XXXI, R. 52], is erroneous in law because of the insufficiency of proof of infringement, and as contrary to fact.

19. Finding XXXII and Conclusion II [R. 52, 56] that the claims in suit are good and valid and cover a new and meritorious invention entitling the patent to a liberal interpretation are erroneous in law and unsupported by and contrary to the evidence.

20. That defendants have not established their defenses of a shop-right license and an implied license under the patent [F. XXXIII, XXXIV, XLVI, R. 53, 55], is erroneous because contrary to law and to the evidence; and erred in failing to find that defendants at all times have had an express as well as an implied license under the patent.

21. That the alleged invention of the patent was made by Garbell prior to his employment by Consolidated [F. XXXV, R. 53], is erroneous as contrary to law and unsupported by the evidence.

22. That Garbell disclosed his alleged invention to others prior to his employment by Consolidated [F. XXXVI, R. 53], is error because contrary to law and not supported by the evidence.

23. That the alleged invention of the patent was rejected by Consolidated [F. XXXVII, R. 53], is error because contrary to law and to the evidence.

24. That the alleged invention of the patent was not developed, perfected, devised, or conceived by Garbell

during his employment by Consolidated [F. XXXVIII, R. 53], is error because contrary to law and unsupported by and contrary to the evidence.

25. That Consolidated took no steps during the employment of Garbell by it to develop or perfect the alleged Garbell invention [F. XXXIX, R. 54], is error because unsupported by and contrary to the evidence; and erred in failing to find that the alleged invention was developed and perfected by and at the expense of Consolidated during such employment.

26. That Consolidated first used the alleged invention of the patent months after Garbell had left its employ without notice to him and after a rejection of the invention [F. XL, R. 54] is error because contrary to the evidence which shows that Consolidated used and tested said alleged invention during his employment by it and with his full knowledge, consent, instigation and approval; and erred in failing to find that such use and tests by Consolidated are represented by Garbell in the patent in suit to be demonstrations of his patent.

27. That Consolidated has never paid, tendered, or offered to pay, under the Invention Agreement, PX-16, the sum of $10.00, or any other sum, to Garbell [F. XLI, R. 54] is erroneous in law because such sum did not accrue to him for the license granted in the agreement, and is contrary to the evidence.

28. The District Court erred in failing to find that at all times while employed by Consolidated, Garbell performed and worked under the Invention Agreement, and by his conduct has recognized that the express license or shop-right is and at all times has been in full force and effect.

29. That during Garbell's employment by Consolidated, it did not at any time assert any right, privilege, or license to the alleged Garbell invention [F. XLII, R. 54], is erroneous as a matter of law and because contrary to the evidence.

30. That offers by Garbell to Consolidated during his employment by it to the use of the alleged invention of the patent were rejected by it [F. XLIII, R. 54], is contrary to law and the evidence.

31. The District Court erred in failing to find that the first assertion by Garbell that he had any rights in the invention of the patent in suit independent of or adverse to Consolidated was made by him long after he had left its employ.

32. That the invention of the patent was complete prior to Garbell's employment by Consolidated [F. XLV, R. 55] is erroneous in law, and in finding that nothing was added thereto and there was no practical carrying out of the invention by Garbell or by Consolidated during his employment by it, as the same is contrary to the evidence.

33. That plaintiffs are entitled to an injunction [F. XLVII, R. 55] is erroneous in law and not supported by the evidence.

34. That the action should be referred to a special master for an accounting [F. XLVIII, R. 56], is erroneous because not supported by the evidence.

35. The District Court erred in failing to grant defendants' motion for a new trial, as the same was well founded in law and fact.

IV.

ARGUMENT.

POINT ONE.

The Alleged Invention Was Not Made Prior to Garbell's Employment by Defendant Consolidated.

The District Court found that Garbell "made" the alleged invention of the patent in suit prior to his employment by defendant Consolidated, and that he fully disclosed it to others prior to such employment [F. XXXV and XXXVI, R. 53]. The error in these findings will immediately be apparent.

As pointed out above, the only evidence offered to support plaintiffs' claim of conception by Garbell prior to his employment is Garbell's oral testimony, wholly uncorroborated by anything [p. 3, *supra*]. While Garbell testified that he had earlier disclosed his idea to Platt and Chin, neither was called as a witness by plaintiffs, nor was their absence explained. The record shows that both Garbell and plaintiffs' attorneys prior to trial had a number of conferences about the lawsuit with Chin, who lives in San Francisco [R. 1115], but he was not called as a witness by them. The legal presumption from this failure to call is that had Platt and Chin been called as witnesses they would have testified adversely to Garbell and the plaintiffs. (See: *Interstate Circuit v. United States,* 306 U. S. 708, 59 S. Ct. 467, 83 L. Ed. 610; *Hann v. Venetian Blind Corp.,* 111 F. 2d 45 (C. C. A. 9th, 1940).)

As a matter of fact, Chin's testimony denying Garbell's assertion of early disclosure to Chin was offered by defendants on their motion for a new trial [R. 66], but the District Court refused to permit such testimony [R. 497], stating in effect that even if Chin had testified, it would not have affected the District Court's conclusions [R. 496].

In any event, we submit that the uncorroborated oral testimony of Garbell is insufficient to carry back his date of alleged invention to any time prior to his employment by Consolidated in 1942. It must be remembered that plaintiffs are trying to carry such date back from July 16, 1946, the date of application for the patent in suit, to 1939, a period of seven years, upon such wholly uncorroborated oral testimony of the patentee, who is also president of both plaintiff corporations, given eleven years after the event. Such uncorroborated oral testimony is insufficient to carry a date of invention back of the application filing date. (See: *McIlvaine Patent Corp. v. Walgreen Co.,* 44 Fed. Supp. 530 (D. C. Ill., 1942; aff'd 138 F. 2d 177; *United States Rubber Co. v. Sidney Blumenthal & Co., Inc.,* 98 F. 2d 767 (C. C. A. 2d 1938); *United States Shoe Machine Corp. v. Brooklyn Wood Heel Corp.,* 77 F. 2d 263 (C. C. A. 2d 1935); *Twentieth Century Machinery Co. v. Loew Mfg. Co.,* 243 Fed. 373 (C. C. A. 6th, 1917); *National Mach. Corp. v. Benthall Mach. Co.,* 241 Fed. 72 (C. C. A. 4th, 1916).)

The "making" of the invention by Garbell prior to employment, relied upon by plaintiffs, was his mere mental concept, divorced from any objective act. Under well-established legal principles, mere mental conception, even if believed, is not "making the invention." This was pointed out succinctly by this Court in *Hann v. Venetian Blind Corp.,* 111 F. 2d 455 at 458 (1940), the quotation appearing in Appendix B, page 1.

A case directly in point is *Conway v. White*, 9 F. 2d 863 (C. C. A. 2d, 1925). There plaintiff was attempting to require specific performance of a covenant by an employee defendant to assign to his employer inventions made during the employment. The employee contended (just as plaintiffs do here) that the invention was made by him prior to his employment. The first machine actually embodying the invention was made during the employment, and the Court *held* that the date of "making" of the invention was the date of completion of such machine, not some earlier conception date.

The rule was early applied in *Clark Thread Co. v. Willimantic Linen Co.*, 140 U. S. 481, 11 S. Ct. 846, 35 L. Ed. 521 (1891), where the Supreme Court held that an invention was not made until embodied in concrete form, saying:

> "It is evident that the invention was not completed until the construction of the machine. A conception of the mind is not an invention until represented in some physical form . . ."

To the same effect, and for the citation of additional decisions supporting the rule, see: *Walker on Patents, Dellers Edition,* pages 298-299.

There is absolutely no evidence of any kind in this action that Garbell ever reduced to practice the alleged invention of the patent in suit prior to his employment by Consolidated. In fact, Garbell stated that prior to such employment no airfoil embodying his invention had ever been designed by *anybody* for an airplane [R. 239]. Therefore, under the law and facts, the alleged invention was not "made" prior to Garbell's employment, and Findings XXXV and XXXVI are clearly erroneous. Also plainly erroneous is Finding XLV, in which the District Court found that the invention was "complete" before Garbell's employment by Consolidated. Since there was no embodying of the idea in physical form or other reduction to practice before such employment, under the above law the alleged invention obviously was not "complete."

POINT TWO.

The Alleged Invention Was Made While Garbell Was Employed by Defendant Consolidated.

The District Court found [F. XXXVIII, R. 53] that the alleged invention was not made, developed, perfected, devised, or conceived by Garbell during his employment by Consolidated. This, we submit, is clearly erroneous because if the invention was not "made" prior to such employment as shown in the preceding section, it must have been "made" during such employment, as it was embodied in physical form, reduced to practice, and its practicability fully demonstrated during such period. This Court need look no further than the admissions of Garbell to satisfy itself of this.

The patent in suit flatly states [R. 612, Col. 10, lines 50-64] that numerous wind-tunnel tests had "demonstrated convincingly that each of the objects of this invention have been fully achieved." Garbell admitted that such wind-tunnel tests included those made by Consolidated of its "Two-Engine Tailless Design" and its XB-46 bomber [R. 260-262], which were made during his employment and which incorporated the alleged invention of the patent in suit. Likewise, Garbell's memo dated March 2, 1945, Plaintiffs' Exhibit 25 [R. 666], plainly admits that "the 'tri-section wing' principle which has been *successfully* applied to the Tailless design, the executive transport, and the XB-46 design, yields several satisfactory wings." Also, Garbell's official disclosure of invention to Consolidated, Defendants' Exhibit D, likewise indicates that the construction had been successfully "tested" [R. 783]. Garbell's admissions, therefore, clearly establish that the alleged invention of the patent in suit was reduced to practice and its practicability fully demonstrated by the work done at Consolidated during his employ by it.

Under *Hann v. Venetian Blind Corp., supra,* and the other authorities set forth in the preceding section of this brief, the alleged invention of the patent in suit was therefore reduced to practice by Consolidated during Garbell's employment by it, and we suggest that as a matter of law the invention must be considered as "made" during such period. As held in the *Hann case, supra,* an invention is not made or completed when it is merely conceived; to complete the invention, it must be reduced to practice.

Likewise, clearly erroneous is Finding XXXIX [R. 54], in which the District Court found that Consolidated took *no* steps to develop or perfect the "Garbell invention" during his employment. As shown by the facts and admitted by Garbell, Consolidated made wind-tunnel models for its "Two-Engine Tailless," its XB-46, and its Model 110, and fully tested them over many months at its own expense, to determine whether wings embodying the alleged invention in suit were practical, and the patent in suit refers to them as establishing the same.

However, we further submit that the evidence indicates that the alleged invention was actually conceived, as well as reduced to practice, while Garbell was employed by Consolidated. The earliest documentary evidence of the alleged invention is the report on the proposed "Two-Engine Tailless Design," submitted in the line of duty by the engineering group composed of Fiul, Rogers, and Garbell, Defendants' Exhibit A [R. 1007], which is dated February 25, 1944. It was not, however, until December 1944, that Garbell submitted his formal disclosure of the alleged invention, Defendants' Exhibit D [R. 775], which he characterized as an "official disclosure of Invention" [R. 789]. Although Garbell was employed on August 7, 1942, and was required by his Invention Agreement [R. 633] "to disclose promptly in writing to the Company's Patent Department" all inventions made by him while employed by it, why was it that he waited until December 1944 to make this particular disclosure? This is unexplained in the evidence, and, we respectfully submit, the only logical inference is that he in fact conceived the alleged invention while so employed.

It is therefore submitted that the alleged invention was both conceived and reduced to practice during Garbell's employ by Consolidated.

POINT THREE.

Defendants Have an Express License Under the Patent in Suit Which Is a Bar to This Action.

The Invention Agreement, Defendants' Exhibit C [R. 633], required that Garbell promptly disclose to Consolidated all inventions *"made, developed, perfected, devised,* or *conceived"* by him during his employment and for one (1) year thereafter. The application for the patent in suit was filed by Garbell within one year after the termination of his employment. Under the agreement, Consolidated had the option to acquire all patent rights to any invention disclosed to it under the agreement, but in the event that it did not exercise such option it still retained a "free shop right" (*i. e.,* a non-exclusive, free license) thereto [*See:* Par. 6, R. 637].

The alleged invention of the patent in suit was officially disclosed by Garbell to Consolidated by his written disclosure dated December 5, 1944, Defendants' Exhibit D [R. 775]. It is to be noted that such disclosure is written on Company stationery, and there is nothing therein to indicate that the conception originated other than as a company project. The disclosure characterizes the conception as a "tested *new* method of airfoil selection" (p. 1) and referred to actual photographs showing "experimentally obtained" characteristics of the wing (p. 9). The disclosure was submitted by Garbell with an intercompany memo dated December 19, 1944 [R. 789], which states: "Please consider this paper an *official disclosure of invention.*" The disclosure was made to Consolidated's patent department, exactly as required by Paragraph 1 of the Invention Agreement. It was not submitted to defendant's management, nor was it submitted as an independent or outside idea. *Eight* other alleged inventions were also submitted by Garbell under his Invention Agreement [R. 353], of which *five* were submitted by him prior to that here at issue, and as to *two* of which Consolidated exercised its option rights under the Invention Agreement and made money payments to Garbell [R. 361-362]. This was not denied by Garbell. This shows the obvious error in Finding of Fact XLI, in which the District Court found that defendant never paid or tendered any sum to Garbell under the Invention Agreement.

The only reasonable interpretation of the foregoing evidence, we respectfully submit, is that Garbell at all times honored and worked under the Invention Agreement, and that when, on December 19, 1944, he submitted his "official disclosure" of the alleged invention of the patent in suit, he did so under and in accordance with the Invention Agreement and that the District Court should have so found. Obviously, if Garbell in fact submitted such disclosure in accordance with the Agreement, it is a direct admission by him that the alleged invention was *made, developed, perfected, devised,* or *conceived* by him during his employment, as otherwise he would have been under no obligation to have made such official disclosure.

It is well established in the law that the actions of the parties construing a contract should be followed by the courts in interpreting the contract. (*See: District of Columbia v. Gallaher,* 124 U. S. 505, 31 L. Ed. 526, 527; *Mitau v. Roddan,* 149 Cal. 14, 84 Pac. 145, 6 L. R. A. 275, 281.)

It is therefore submitted that Garbell himself construed his alleged invention of the patent in suit as falling within the terms of his Invention Agreement and licensed thereby, and that this should have been an end to the matter. Actions speak louder than words. It is further submitted that the District Court's Findings of Fact XXXIII, XLV, and XLVII are obviously erroneous as clearly contrary to the weight of the evidence and unsupported by any competent evidence.

POINT FOUR.

Defendants Have an Implied-in-Law License Under the Patent in Suit Which Is a Bar to This Action.

The patentee Garbell, starting in 1944, at every opportunity during his employment by Consolidated urged it to use the alleged invention of the patent in suit, and it did so in the design and testing of its "Two-Engine Tailless Design," its XB-46 bomber, its executive transport, and its Model 110 airplane which was the forerunner of the Model 240 "Convair" here in suit.

Under the law, this plainly created an implied-in-law license to defendant to continue to use the construction. The general rule as to implied licenses is stated in *De Forest Radio Telephone & Telegraph Co. v. United States,* 273 U. S. 236, 71 L. Ed. 625, quoted in Appendix B, pages 1 and 2.

A case in point with plaintiffs' claimed statement of facts in this case is *Elzilaw Co. v. Knoxville Glove Co.,* 22 F. 2d 962 (C. C. A. 2d, 1927). There an employee had actually filed a patent application on an invention before employment but during employment urged his employer to use the invention. The attempts of the employer were unsuccessful during the employment, but finally after termination of the employment it was successful and started to make and sell devices which included the invention. The Court held that the employer had an implied license which barred the action, the pertinent language of the decision being quoted in Appendix B, page 2.

A similar factual situation was present in *Tin Decorating Co. v. Metal Package Corp.,* 29 F. 2d 1006 (aff'd 37 F. 2d 5, and cert. den.), in which the Court found an implied license, pertinent portions of the opinion being quoted in Appendix B, page 3.

The rule in this Circuit as to shop-right or implied license is stated in *Gate-Way v. Hillgren,* 82 Fed. Supp. 546 (D. C. Calif., 1949, aff'd 181 F. 2d 1010), pertinent portions of the decision being quoted in Appendix B, pages 3 and 4.

For many other decisions finding a shop-right or implied license in an employer as to an employee's invention from activities no more favorable to the employer than in the present case, *see:* Annotations in 16 A. L. R. 1204; 32 A. L. R. 1041; 44 A. L. R. 593; 85 A. L. R. 1522, and 153 A. L. R. 1002.

It is therefore submitted that defendant has a free implied-in-law license (*i. e.,* shop-right) to use the alleged invention of the patent in suit, which is a complete bar to this action. We submit that Findings XXXIV and XLVI, finding no shop-right or implied license, are clearly erroneous in law and fact.

In Findings XIII, XXXVII, XL, and XLIII, the District Court found that defendant "rejected" the alleged invention. This misconception of the facts apparently was the controlling factor in the decision of the case by the District Court, as it is adverted to strongly in the Memorandum Decision [R. 40-43], the pertinent portions being quoted in Appendix B, page 4. Obviously, defendant Consolidated did not consider the alleged invention "impractical," nor did it "reject" it, as it adopted and used the idea in its "Two-Engine Tailless Design," in its executive transport, in its XB-46 bomber, and in its Model 110, all at the suggestion of Garbell.

The misconceptions of the trial court as to the evidence are illustrated by its statement that the invention was disclosed to "the head of defendants' Patent Department, on March 2, 1945, and passed through channels, bears the final rejection in a pencilled notation, 'Not (interested) at this time.' (Plaintiff's Exhibit 25.)" Exhibit 25, as it and the evidence show, was a suggestion by Garbell that his wing idea be used as an alternate wing in the Model 37 airplane already built, and was made to *T. P.* Hall, chief engineer, not to *D. A.* Hall, of the Patent Department. Exhibit 25 was not sent to defendants' Patent Department at all, and there is no suggestion in the evidence that it was ever seen by the Patent Department. The "pencilled notation" by T. P. Hall obviously was merely a decision not to adopt Garbell's suggestion *for that particular airplane at that particular time;* it was not "rejection" of the invention. The District Court, after entering such Memorandum Decision, so interpreting the facts, then refused to permit testimony by T. P. Hall to explain the Exhibit 25 and his notation thereon [Defts. Motion for New Trial, R. 65]. We suggest that Findings XXVII, XL, and XLIII are obviously unfounded and contrary to the evidence.

POINT FIVE.

The Claims in Suit Are Invalid for Anticipation by and Lack of Invention Over the Prior Art.

(a) The Prior Art—In General.

So far as this record shows, no airplane which manifested undesirable tip stall was ever continued in use. The design of the wing was promptly changed by varying the geometry, including the camber and thickness relationships of the wing sections to eliminate tip stall and move the initial stall area inboard. The variations were made according to the teachings of world-wide-known literature and common knowledge of aircraft designers.

Among this literature, *N. A. C. A. Report No. 627* [part of DX-UU] describes twenty-two wings of different taper ratio specifically designed to avoid tip stall. Page 14 states:

> "The tapered N.A.C.A. 23013-43010 (Fig. 19) is an example of a wing designed to avoid tip stalling. In order to stall at the center, a combination of moderate taper, washout and progression to sections having increasing CL max (increased camber) toward the tips was used."

The *N. A. C. A. Report 703* [DX-XXX], entitled "Design Charts Relating to the Stalling of Tapered Wings," provides a comprehensive discussion of the problem and of the technical aspects thereof. It stated four methods of moving stall inception inward from the wing tip to avoid tip stall, one of which was to increase the mean-line camber from root to tip and to decrease the thickness ratio therebetween (pp. 1-2). It pointed out that the point of stall inception is the point of tangency of the CL and CL max. curves (pp. 2-3), and that the rate of separation of the lift-distribution curves indicates the rate of stall progression in both directions from the point of tangency (p. 6), which was confirmed by plaintiffs' witness Garbell [R. 195-199]. In its Figure 6 (p. 4), it shows lift-distribution curves for such a cambered wing. in which the rate of separation of the two curves inboard is much less than that outboard of the point of tangency (*i. e.,* stall origin), which plainly indicated from the general teaching of the report that stall inception in such wings occurs at about 60% of semi-span and progresses inboardly at a faster rate than outboardly, a result set forth and attributed to the patent in suit [R. 610, Col. 5, lines 7-9].

N. A. C. A. Note 713, page 3 [R. 868] is directed to avoid tip stalling of tapered wings, and states:

> "The increase in camber produces an increase in CL max of the sections near the tips and thereby causes the stalling point to move inward."

These wings prevented tip stall and retained straight-line fairing, for the obvious reason that straight-line fairing produces a more simple and therefore less costly structure. Deviation from linear fairing is not an object sought but a mere incident of relative camber variation in different stations of the wing, which designers and builders may desire to avoid to provide simplicity in fabrication. Nonetheless, the desired stall characteristics were conventionally achieved by camber and thickness variation distributed spanwise of the wing. In consequence, the prevention of tip stall by means of variation in camber and thickness ratio was an old and well-known expedient in aircraft wing design. The Examiner [file wrapper, PX-33] correctly stated: "by well known means a wing may be designed to stall at any point."

Wings which utilized variation in the spanwise distribution of cambers and thickness which deviated from linear fairing for avoiding tip stall were also widely known and used.

The Royal Aeronautical Society article [DX-WW, R. 905, 906], states:

> "In predicting the point where stalling will first occur, it is necessary to make allowance for the actual stalling angle of a section at any point of the span, and by varying the geometric angle and the characteristics of the section (thickness/chord ratio and camber) it should be possible to control to some extent the commencement of burbling in relation to the wing plan form."

That the author of this article contemplated more than linear spanwise variation of camber from a root section of smallest camber to a tip section of greater camber is clearly shown in Figure 12a [R. 909] in which a wing is graphically depicted having the following section characteristics:

	Root Section	Section at .62 Semi-Span	Tip Section
Mean Camber	2%	6%	6%
Thick Ratio	15%	10%	2%

Since the camber at the interjacent section is *equal* to the camber at the tip, it must be greater than the camber at the same station obtained by linear fairing, and therefore the showing clearly meets those claims of the patent in suit in which the camber at the intermediate station is either *at variance* from or is *greater* than the linear.

Exhibit CCC [R. 950], published in England in 1938, states:

> "A better method of preventing tip stalling, or one which may be profitably employed in conjunction with a small degree of twist, is to increase the camber from root or tip, or at least over the outer section of the wing. * * * Another solution to the tip-stalling problem to be used with camber variation, is provided by suitable grading of wing thickness over the outer portion of the span,"

This camber variation over the *outer sections* of the wing inherently results in non-lineal fairing and in camber increase from root to tip, for preventing tip stall, either alone, or when combined with thickness variation.

Zien's article [DX-XX, R. 913], plainly points out that by profile (*i. e.,* airfoil section) variation, airflow separation (*i. e.,* stall) can be made to occur at the wing tip later than at the center of the wing, and that lateral stability is "guaranteed even at stall by the delayed separation of the flow at the wing tips" [R. 913]. It states that the camber should be proportionately large at the wing tips [R. 926], and that wind-tunnel tests had shown that with a highly tapered wing having a tip with a large section-lift coefficient (*i. e.,* large camber), the stall starts at the center of the wing [R. 930]. Finally, in Figure 12 [R. 935], it gives the sections of a five-section wing in which the root has the least camber and greatest thickness ratio, and the tip has the greatest camber and the least thickness ratio and interjacent sections having a camber greater and a thickness ratio less than that obtainable by straight-line fairing [R. 400-402, 468-472]. These ratios are graphically shown in Defendants' Exhibit RRR [R. 933, 403], and are applied against claim 1 of the patent in Plate IV adjoining this page. The article fully explains the profile systematics and the magnitude and position of the camber and the thickness ratio in controlling the span-wise distribution of lift coefficients for moving the stall point inwardly from the tips. Here are taught all the necessary factors and calculations for the selection of airfoil sections distributed spanwise for eliminating tip stall and initiating the stall adjacent the mid-span of the wing which inherently results in camber and thickness deviation.

Again, a sailplane called the "Wippsterz" is described in a 1937 publication [DX-AAA, R. 939], having a three-section wing in which the root section has the least mean-line camber and greatest thickness ratio, the tip has the greatest mean-line camber and the least thickness ratio, and the interjacent section has a mean-line camber and thickness ratio at variance with that obtainable by straight-line fairing [R. 405-406]. The geometry of this wing is shown graphically in Defendants' Exhibit SSS, which shows that in the "Wippsterz" the interjacent section had a mean-line camber *greater* than that obtainable by straight-line fairing, and a thickness ratio *less* than that obtainable by straight-line fairing. The "Wipp-sterz" construction is applied against claim 12 of the pat-ent in suit in accompanying Plate V.

Defendants' Exhibit VV [R. 894], a 1936 publication, describes a wing used by Curtiss-Wright Airplane Co., composed of airfoil sections in which the under side of the leading edge of the wing is faired out and the leading

"LUFTFAHRTFORSCHUNG" (1938) - DEF. EXHIBIT - XX

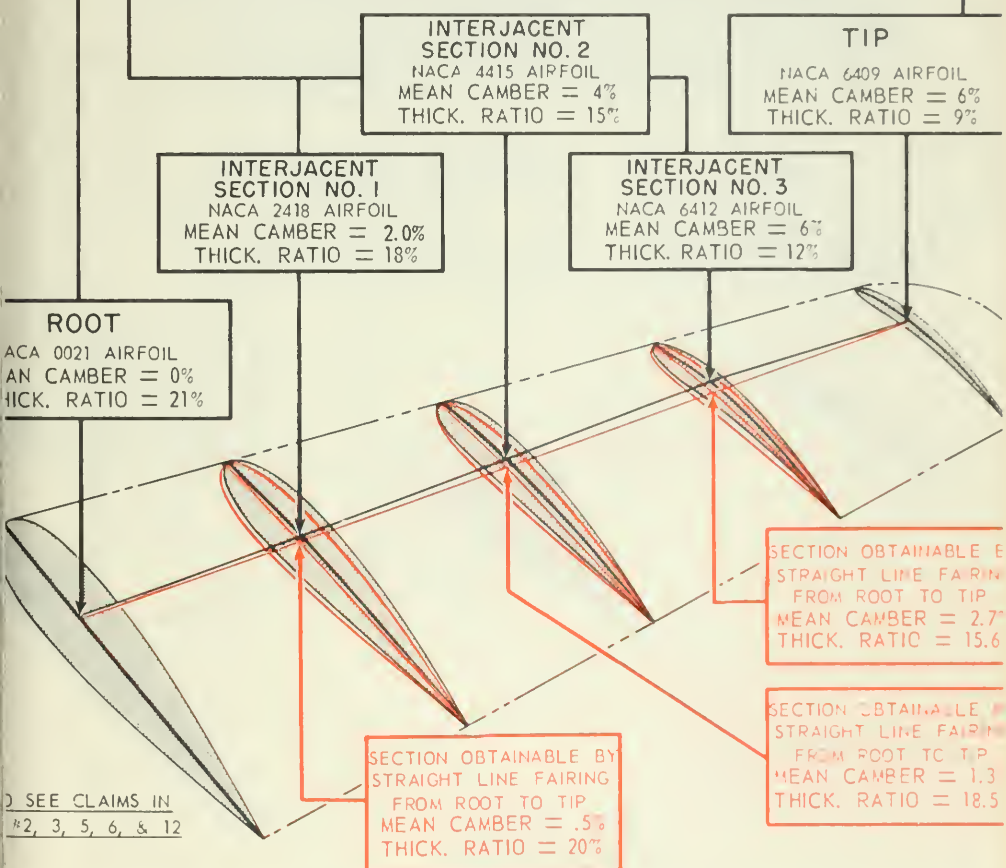
APPLIED TO CLAIMS OF GARBELL PATENT IN SUIT

CLAIM 1 A LIFTING SURFACE WITH THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS, IN WHICH

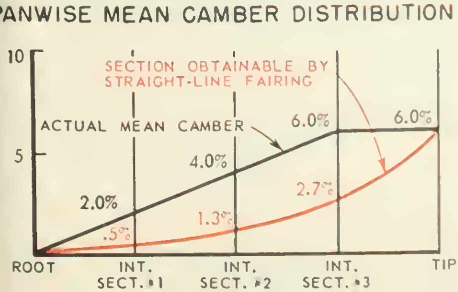
THE FIRST SECTION WITH THE SMALLEST MEAN-LINE CAMBER IS LOCATED AT THE ROOT,

THE SECOND SECTION WITH THE GREATEST MEAN-LINE CAMBER IS LOCATED AT THE FLUID-DYNAMICALLY EFFECTIVE TIP,

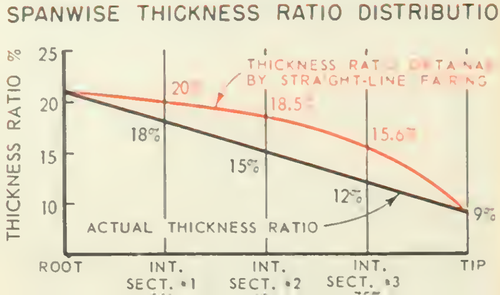
AND THE THIRD OR ADDITIONAL FLUID-FOIL SECTIONS ARE LOCATED AT STATIONS INTERJACENT BETWEEN THE ROOT AND THE TIP, WHEREIN THE VALUES OF THE MEAN-LINE CAMBER OF THE INTERJACENT FLUID-FOIL SECTIONS ARE GREATER THAN THE VALUES OF THE MEAN-LINE CAMBER OBTAINABLE AT THE RESPECTIVE SPANWISE STATIONS BY MEANS OF STRAIGHT-LINE FAIRING BETWEEN THE FLUID-FOIL SECTION LOCATED AT THE ROOT OF THE LIFTING SURFACE AND THE FLUID-FOIL SECTION LOCATED AT THE TIP OF THE LIFTING SURFACE.



PANWISE MEAN CAMBER DISTRIBUTION



SPANWISE THICKNESS RATIO DISTRIBUTIO



THE FS16 "WIPPSTERZ" SAILPLANE

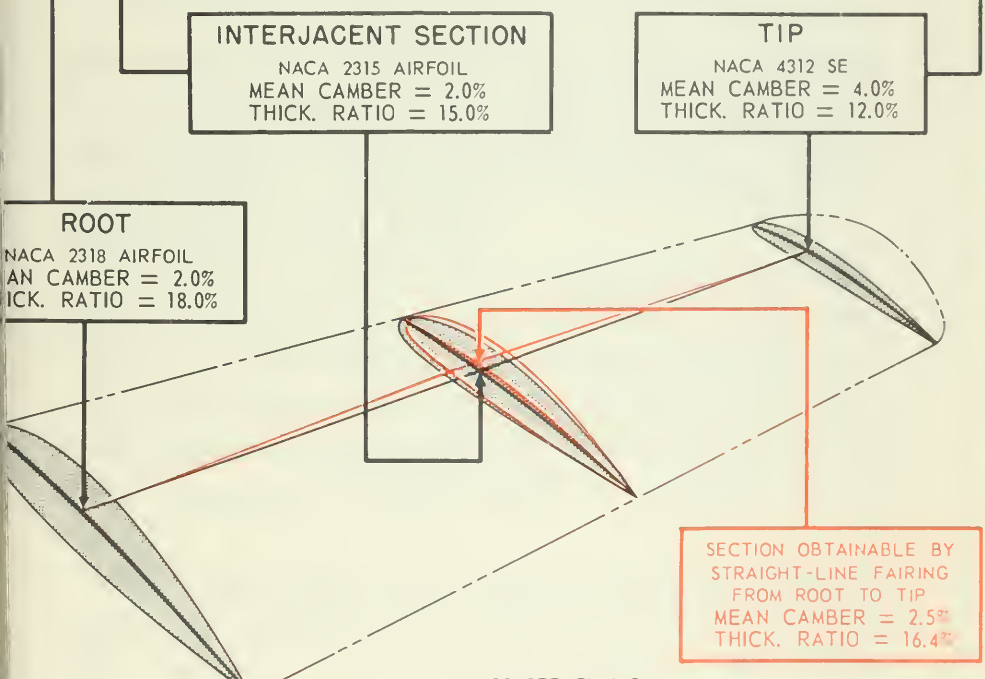
APPLIED TO CLAIMS OF GARBELL PATENT IN SUIT

CLAIM 12 A LIFTING SURFACE WITH THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS, IN WHICH

THE FIRST SECTION WITH THE SMALLEST MEAN-LINE CAMBER AND GREATEST THICKNESS RATIO IS LOCATED AT THE ROOT,

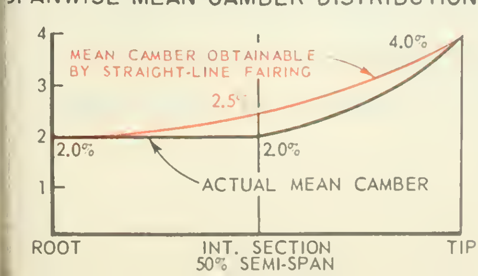
THE SECOND SECTION WITH THE GREATEST MEAN-LINE CAMBER AND SMALLEST THICKNESS RATIO IS LOCATED AT THE FLUID-DYNAMICALLY EFFECTIVE TIP,

AND THE THIRD OR ADDITIONAL FLUID-FOIL SECTIONS ARE LOCATED AT STATIONS INTERJACENT BETWEEN THE ROOT AND THE TIP, WHEREIN THE VALUES OF THE THICKNESS RATIO OF THE INTERJACENT FLUID-FOIL SECTIONS ARE SMALLER THAN THE VALUES OF THE THICKNESS RATIO OBTAINABLE AT THE RESPECTIVE SPANWISE STATIONS BY MEANS OF STRAIGHT-LINE FAIRING BETWEEN THE FLUID-FOIL SECTION LOCATED AT THE ROOT OF THE LIFTING SURFACE AND THE FLUID-FOIL SECTION LOCATED AT THE TIP OF THE LIFTING SURFACE.

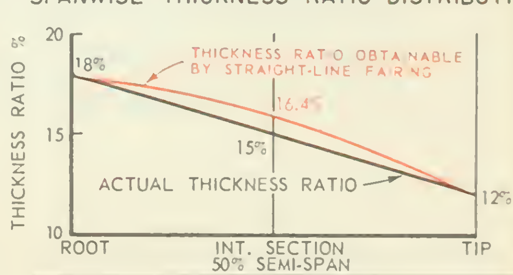


ALSO SEE CLAIMS IN SUIT #2, 3, 5, & 6

SPANWISE MEAN CAMBER DISTRIBUTION



SPANWISE THICKNESS RATIO DISTRIBUTI



edge radius increased in successive steps [R. 899] from the tip inboard, thus increasing the airfoil camber toward the tip. The article states that the result of this change was that [R. 899]

> "the leading edge at the tip remained unstalled throughout"

and that

> "* * * the stall of the wing started along the trailing edge near the midpoint of the semi-span and proceeded gradually in all directions * * * the stall became smooth and more controllable"

Here we have tip stall prevention, with the stall initiating at the trailing edge near the midpoint of the semi-span and proceeding gradually in all directions, in a wing composed of different airfoil sections which resulted in camber deviation from linear fairing.

The Curtiss-Wright, Glenn L. Martin and Vultee airplanes, hereinafter more fully explained, achieved stall initiation in the mid-span of the wing and spreading inboard and outboard with wings having camber and thickness variations which resulted in deviation from that derived from linear fairing exactly as described in the patent.

Stall which initiated near semi-mid-span and spread inboard and outboard was abundantly old in the art and thus was not a distinguishable attribute to the patent in suit.

There is no competent evidence in this record that the remedy for any airplane with objectionable tip stall was not known and available. The evidence is to the effect that when, in the course of the development of a particular airplane design, tip stall was manifested in the preliminary procedure, such as wind-tunnel tests, it was promptly eliminated as a matter of engineering routine by variations of camber and thickness according to the teachings in the literature and by so doing moved the initial stall point inwardly of the tip, as occurred in connection with the Glenn L. Martin and Curtiss-Wright airplanes hereinafter discussed. There was no unsolved problem in tip stall prevention.

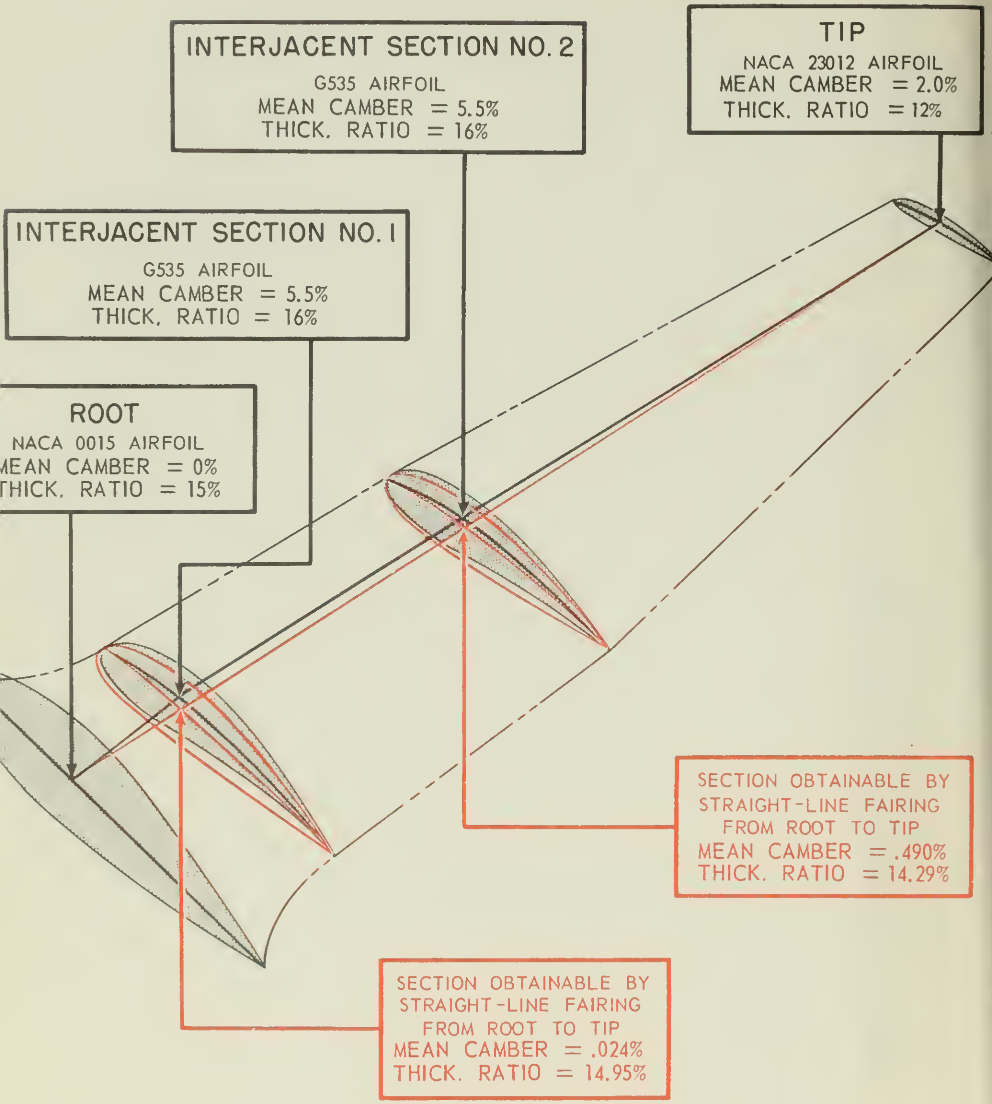
It is therefore plain that the alleged invention of the patent in suit does not provide any "novel stall characteristic."

(b) The "Pinguino" Sailplane.

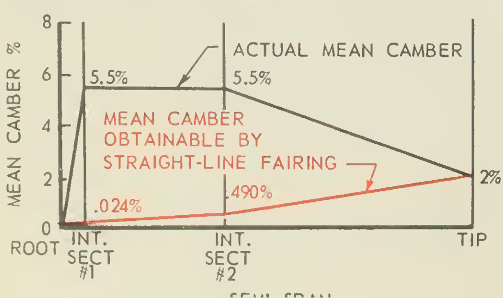
Garbell in 1936 and 1937 in Italy helped design, build, and fly a sailplane (*i. e.,* a "glider") named the "Pinguino." He admitted that the *"Pinguino" embodied the principles of the patent in suit* [R. 239-241]. He admitted that some of the flight and wind-tunnel tests referred to in the patent in suit as demonstrating "convincingly that each of the objects of this invention has been fully achieved" [Col. 10, lines 50-58] were those of the "Pinguino" [R. 162, 165]. He admitted [R. 180-181] that the "Pinguino" wing construction was fully described in a 1938 publication, Defendants' Exhibit G [R. 791]. It is also described in other prior-art publications [R. 943, 952, 961, 964].

Garbell also admitted that the "Pinguino" wing had four control sections providing camber changes between root and tip which were non-lineal, the purpose of which was to move the point of stall inception inboardly from the tip [R. 240-241, 479-480]. The camber and thickness

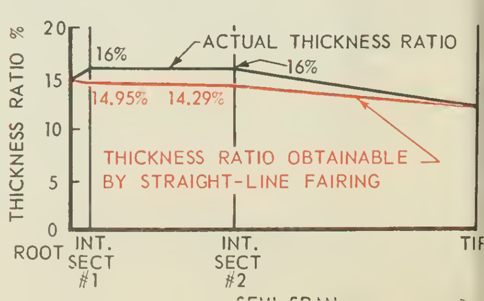
THE "PINGUINO" G.P.I. SAILPLANE



PANWISE MEAN CAMBER DISTRIBUTION



SPANWISE THICKNESS RATIO DISTRIBUT



geometry of the "Pinguino" wing are shown in accompanying Plate VI.

Plaintiffs are in this dilemma: If they rely upon the "Pinguino" wing as conception or reduction to practice of the alleged invention of the patent in suit, then the patent in suit is plainly invalid as being fully described in such printed publications in evidence more than one year prior to the application for the patent in suit; on the other hand, if they do not rely upon the "Pinguino" as such conception, there is nothing to support their contention that Garbell "made" the invention prior to his employment by Consolidated.

It now appears that a second patent, No. 2,498,262, was obtained by Garbell after this suit was filed as a continuation-in-part or, in effect, as an original part, of the patent in suit, and therefore we ask this Court to take judicial notice of it. A copy of this second Garbell patent is included as Appendix C at the end of this brief.

Garbell in this continuation patent claims the *identical* camber progression disclosed in the "Pinguino." Each claim specifies that "the mean-line camber at the interjacent section *exceeds* the mean-line camber of the more highly cambered tip section," as it was in the "Pinguino." The second patent asserts stall characteristics which are *identical* with those of the wing of the patent in suit (compare the stall pattern diagrams, Fig. 3 of the patent in suit and Figure 3 of the second Garbell patent). Thus the wings in the "Pinguino" as described in the publications of 1937-8, the patent in suit, and the second patent, produce identical stall results, and constitute a statutory bar against a patent claim in 1946, such as those in patent in suit, for achieving the same stall results.

N. A. C. A. 2309 airfoil at the tip, or a constant 2% camber from root to tip, with thickness decreasing linearly from 15% at the root to 9% at the tip.* The Lombard article states [R. 899]:

> "The stall of the wing was observed in flight * * * to start at the leading edge near the right wing tip and progress rapidly to cover the whole tip portion * * *"

To correct this unsatisfactory stall, the wing was then modified by building up the tip to form a new airfoil designated the CW-19, having an increased camber of 3.4% [R. 899, 900, 998] and fairing this linearly into the original section at Section rib 4 (about 30% of the semi-span) [R. 386]. The wing had minimum camber at the root, greatest camber at the tip, and an interjacent section at the rib 4 having camber at variance with (less than) that obtainable with straight-line fairing.

This modification completely corrected the stall difficulty with the Model 19 [R. 381] as shown by flight tests [R. 384]. According to Lombard [R. 899]:

> "The wool tufts showed that the stall of this wing started along the trailing edge near the mid-point of the semi-span and proceeded gradually in all directions. * * * the whole character of the stall became smooth, more controllable."

In 1939, a new version of the Model 19 was designed and built by Curtiss-Wright, designated the Model 23. In the wing of this airplane, the airfoil sections at rib 4 and

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*In the NACA airfoil designations, the first digit represents the mean camber in per cent, and the last two digits represent the thickness in per cent, thus NACA 2309 has 2% camber, and 09% thickness.

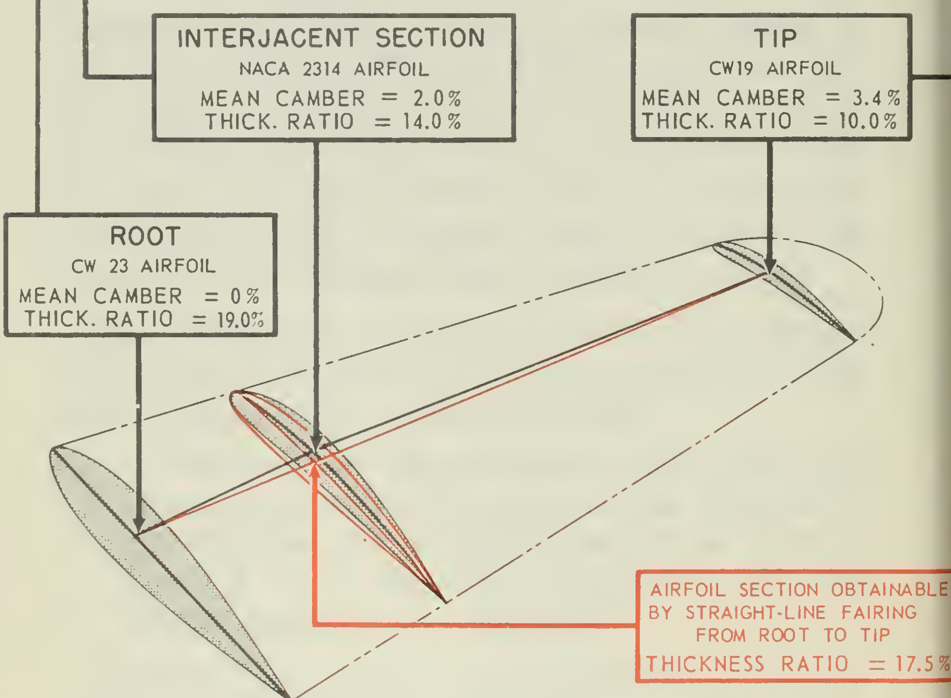
THE CURTISS-WRIGHT MODELS 21B & 23 AIRPLANES APPLIED TO GARBELL PATENT IN SUIT

CLAIM 12 A LIFTING SURFACE WITH THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS, IN WHICH

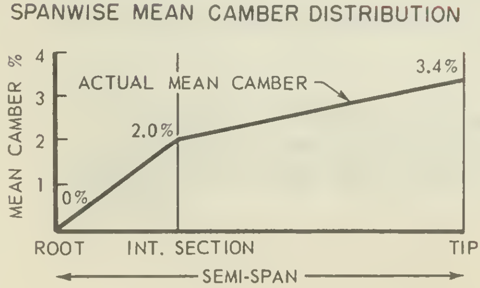
THE FIRST SECTION WITH THE SMALLEST MEAN-LINE CAMBER AND GREATEST THICKNESS RATIO IS LOCATED AT THE ROOT,

THE SECOND SECTION WITH THE GREATEST MEAN-LINE CAMBER AND SMALLEST THICKNESS RATIO IS LOCATED AT THE FLUID-DYNAMICALLY EFFECTIVE TIP,

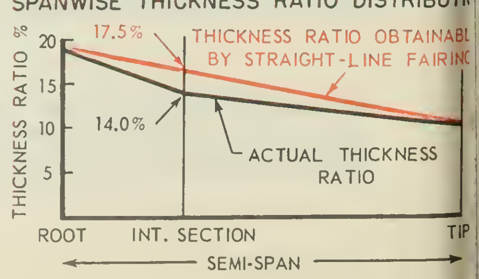
AND THE THIRD OR ADDITIONAL FLUID-FOIL SECTIONS ARE LOCATED AT STATIONS INTERJACENT BETWEEN THE ROOT AND THE TIP, WHEREIN THE VALUES OF THE THICKNESS RATIO OF THE INTERJACENT FLUID-FOIL SECTIONS ARE SMALLER THAN THE VALUES OF THE THICKNESS RATIO OBTAINABLE AT THE RESPECTIVE SPANWISE STATIONS BY MEANS OF STRAIGHT-LINE FAIRING BETWEEN THE FLUID-FOIL SECTION LOCATED AT THE ROOT OF THE LIFTING SURFACE AND THE FLUID-FOIL SECTION LOCATED AT THE TIP OF THE LIFTING SURFACE.



SPANWISE MEAN CAMBER DISTRIBUTION



SPANWISE THICKNESS RATIO DISTRIBUTI



THE CURTISS-WRIGHT MODELS 21B & 23 AIRPLANES APPLIED TO CLAIMS OF GARBELL PATENT IN SUIT

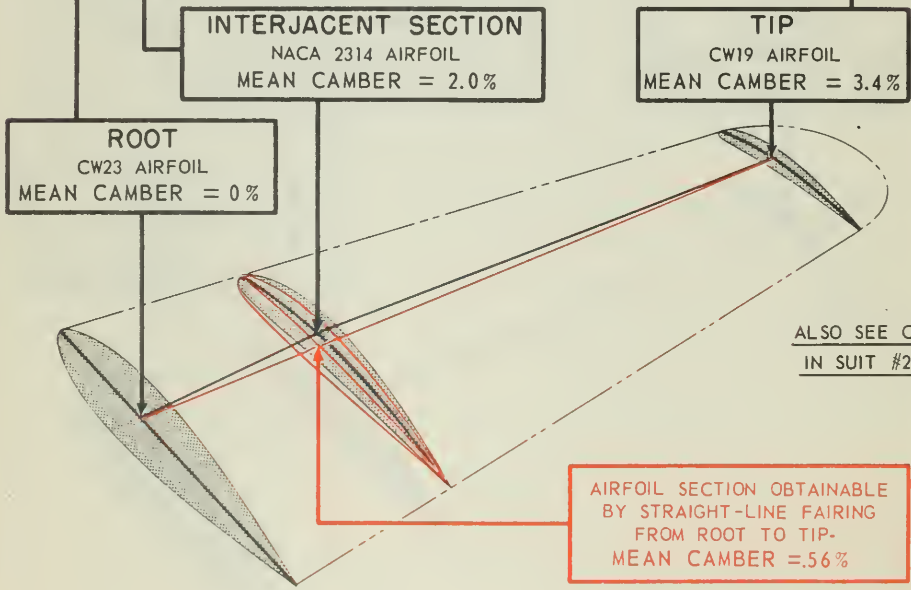
CLAIM I A LIFTING SURFACE WITH THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS, IN WHICH

THE FIRST SECTION WITH THE SMALLEST MEAN-LINE CAMBER IS LOCATED AT THE ROOT,

THE SECOND SECTION WITH THE GREATEST MEAN-LINE CAMBER IS LOCATED AT THE FLUID-DYNAMICALLY EFFECTIVE TIP, AND

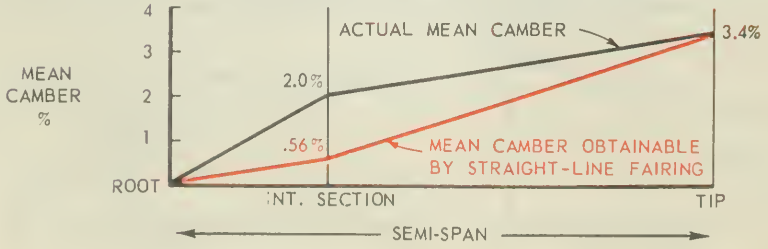
THE THIRD OR ADDITIONAL FLUID-FOIL SECTIONS ARE LOCATED AT STATIONS INTERJACENT BETWEEN THE ROOT AND THE TIP, WHEREIN THE VALUES OF THE MEAN-LINE CAMBER OF THE INTERJACENT FLUID-FOIL SECTIONS ARE GREATER

THAN THE VALUES OF THE MEAN-LINE CAMBER OBTAINABLE AT THE RESPECTIVE SPANWISE STATIONS BY MEANS OF STRAIGHT-LINE FAIRING BETWEEN THE FLUID-FOIL SECTION LOCATED AT THE ROOT OF THE LIFTING SURFACE AND THE FLUID-FOIL SECTION LOCATED AT THE TIP OF THE LIFTING SURFACE.



ALSO SEE CLAIMS IN SUIT #2 & 3

SPANWISE CAMBER DISTRIBUTION



the tip were retained from the Model 19 design, but the root section was modified to a new section designated the CW-23 having 0% camber and 19% thickness. The relationship of the resulting wing to the construction and claims of the patent in suit is shown in accompanying Plates VII and VIII.

One Model 23 airplane was built [R. 379], and in 1940-41 twenty-four airplanes designated Model 21B having the identical wing geometry as the Model 23 were built and delivered to the Dutch government [DX-QQQ, and R. 383].

As shown on Plates VII and VIII, and established by DX-NNN [981] and the testimony of Oldendorph [R. 380-382], the wing of the Models 23 and 21B airplane had the smallest mean-line camber at the root, the greatest mean-line camber at the tip, and an interjacent station at about 30% semi-span having a camber at variance with and greater than the camber obtainable by straight-line fairing. The root section had the greatest thickness, the tip the least, and the thickness at the interjacent section was less than that obtainable by linear fairing.

Plates VII and VIII show that there is no substantial difference between the structure of the claims in suit and the Curtiss-Wright airplanes, Models 21B and 23, the same variances of camber and thickness ratios with straight-line fairing existing. The inboard stall which Garbell asserts for his patent is fully described in the publication [DX-VV]. These airplanes constituted an actual accomplishment of this stall, while the Garbell patent was, at most, a prediction. The references to the polygon enveloping the curve representing the spanwise distribution specified in claims 2, 3, 5 and 6 do not define novelty in structure [R. 333] and were inherent in the Curtiss-Wright wing designs.

We respectfully submit that the Curtiss-Wright airplanes embodied a wing construction which anticipates the claims in suit in every substantial respect.

(d) The Glenn L. Martin Co. Prior Airplanes—Models B-26 and PBM.

Also a direct and complete anticipation of the claims in suit is the B-26 airplane, extensively made and sold by the Glenn L. Martin Company, of Maryland. About 5,200 of the B-26 airplanes were made and sold by the Martin Company during the period 1941 to 1945 [R. 501].

The geometry of the wing of the B-26 airplane is illustrated in accompanying Plate IX, in which claim 2 of the patent in suit is applied thereto. Every other claim in suit may be applied equally well. In Plate IX, the camber and thickness ratio values are in accordance with Martin Co. chart appearing in its Engineering Report No. 1484 [R. 845].

In the initial design of the B-26 by the Martin Company, it was anticipated that the proposed wing would have an undesirable tip stall. This is plainly shown by the Martin Company Engineering Report No. 1326, Defendants' Exhibit EE, and was confirmed by the witness Trimble, chief aerodynamics engineer of the Martin Company [R. 508]. To correct this anticipated tip stall defect, the wing of the wind-tunnel model of the B-26 was modified by increasing the camber of the tip section and fairing this increased camber into an interjacent station. This is clearly described in Report 1326, and was confirmed by the witnesses Trimble [R. 508-509] and Clark [R. 580-585]. As shown by Report 1326, a number of

THE GLENN L. MARTIN MODEL B26 AIRPLANE APPLIED TO CLAIMS OF GARBELL PATENT IN SUIT

AIM 2 A LIFTING SURFACE WITH THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS, IN WHICH

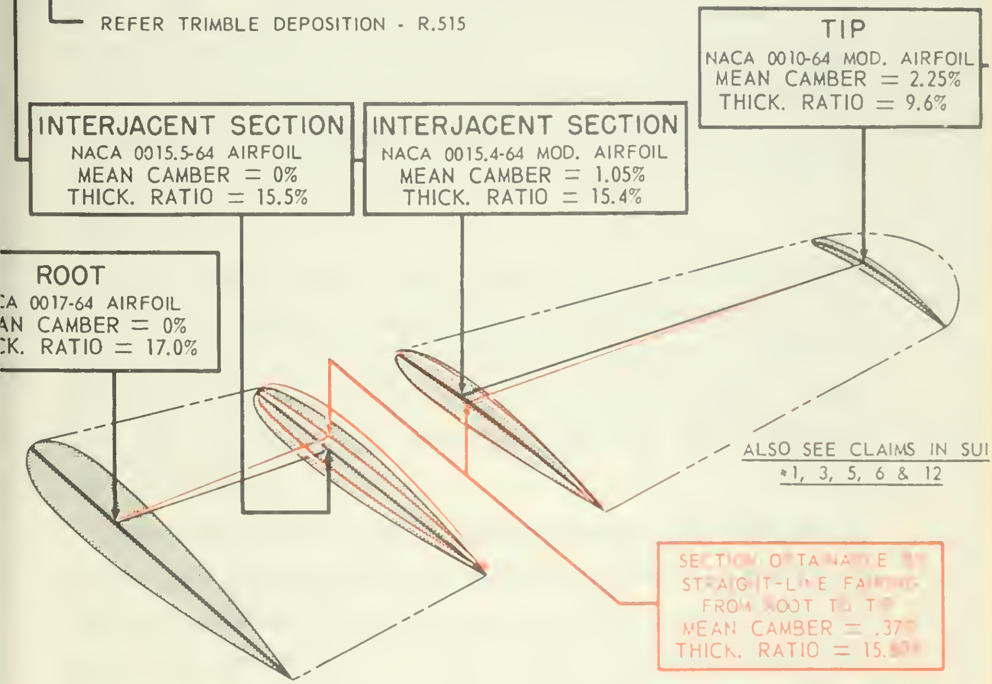
THE FIRST SECTION WITH THE SMALLEST MEAN-LINE CAMBER IS LOCATED AT THE ROOT,

THE SECOND SECTION WITH THE GREATEST MEAN-LINE CAMBER IS LOCATED AT THE FLUID-DYNAMICALLY EFFECTIVE TIP,

AND THE THIRD OR ADDITIONAL FLUID-FOIL SECTIONS ARE LOCATED AT STATIONS INTERJACENT BETWEEN THE ROOT AND THE TIP, WHEREIN THE VALUES OF THE MEAN-LINE CAMBER OF THE INTERJACENT FLUID-FOIL SECTIONS ARE AT VARIANCE WITH THE VALUES OF THE MEAN-LINE CAMBER OBTAINABLE AT THE RESPECTIVE SPANWISE STATIONS BY MEANS OF STRAIGHT-LINE FAIRING BETWEEN THE FLUID-FOIL SECTION LOCATED AT THE ROOT OF THE LIFTING SURFACE AND THE FLUID-FOIL SECTION LOCATED AT THE TIP OF THE LIFTING SURFACE,

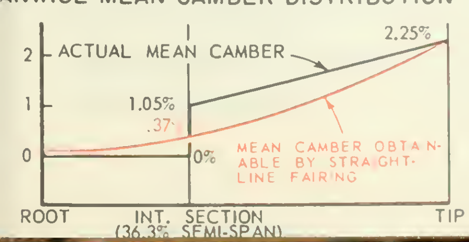
SAID THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS HAVING VALUES OF THE MEAN-LINE CAMBER SELECTED IN SUCH MANNER THAT THE RESULTING SPANWISE DISTRIBUTION OF MAXIMUM ATTAINABLE SECTION LIFT COEFFICIENTS OF THE THREE OR MORE CONTROLLED SECTIONS FORMS A CURVILINEAR POLYGON ENVELOPING A CURVE REPRESENTING THE SPANWISE DISTRIBUTION OF SECTION LIFT COEFFICIENTS FOR A GIVEN PLANFORM ACTUALLY PREVAILING AT THE MAXIMUM ATTAINABLE LIFT COEFFICIENT OF THE LIFTING SURFACE.

REFER TRIMBLE DEPOSITION - R.515

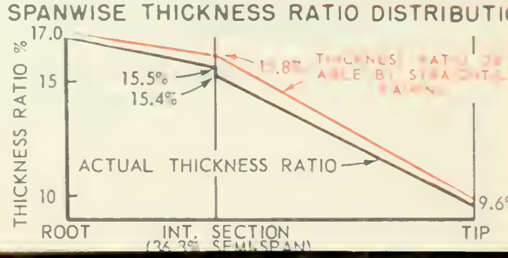


ALSO SEE CLAIMS IN SUIT #1, 3, 5, 6 & 12

ANWISE MEAN CAMBER DISTRIBUTION



SPANWISE THICKNESS RATIO DISTRIBUTI



different designs were wind-tunnel tested, and a wing with a "drooped nose" (*i. e.*, increased camber) at the tip, defined as the "No. 2, Leading Edge," was adopted for the final design of the B-26 airplane [R. 509]. The B-26 series of airplanes as actually made and sold incorporated this construction [R. 509, 519, 582-583].

This change in construction, embodied in the B-26 airplanes as they were actually made and sold, provided a wing such that the "airfoils between the root and the tip are not the result of straight-line fairing between root and tip" [R. 506], but, in fact, the camber was greater than that obtainable by straight-line fairing [R. 509, 584]. The specific construction of the B-26 wing is detailed in the evidence by Reports No. 1326 [DX-EE] and No. 1484 [DX-FF], both of which were fully identified, confirmed, and elaborated upon by the witnesses Trimble and Clark. Trimble actually wrote Report No. 1326 [R. 508].

As a result of the wing change in the B-26, the point of stall inception was moved inwardly from the tip [the point "A" on p. 10 of DX-EE], to about the middle of the semi-span [the point "B" on p. 10, DX-EE], which was the very purpose of the change [R. 510, 538-539, 552, 572-573].

These airplanes actually produced the stall inboard of the tip and approximately at mid-semi-span, suppressed tip stall and achieved in substance the result asserted for the patent by deviation of camber and thickness from the values obtained by straight-line fairing. Thus, the B-26 airplane had substantially the same elements, which produced substantially the same result in substantially the same way as the patent in suit, and the claims in suit are plainly anticipated thereby and invalid.

That B-26 airplanes were actually made and sold in quantity between 1940 and 1945 cannot be doubted from the evidence, which shows purchase contracts [R. 821], packing orders [R. 827], a delivery receipt [R. 828], a data sheet [R. 833], and photographs [R. 846], corroborated by the testimony of Trimble, Clark, and Boardley (contract administrator).

The Martin B-26 and PBM-3 aircraft were established in the evidence entirely by depositions and by documentary exhibits. The District Court neither heard nor saw any of the witnesses to such prior uses, and therefore enjoyed no superiority over this Court in the opportunity to evaluate the evidence with regard thereto. Under such circumstances, this Court is free to disregard the Findings of Fact in so far as they relate to the B-26 prior-use airplane. (*See: Equitable Life Assurance Society v. Irelan,* 123 F. 2d 462 (C. C. A. 9th, 1941); *Himmel Bros. Co. v. Serrick Corp.,* 122 F. 2d 740 (C. C. A. 7th, 1941).)

The Glenn L. Martin Company built and extensively sold another airplane, the PBM-3, in which tip stall was avoided by the use of "three control-sections" in the wing.

The PBM-3 airplanes had a gull type of wing, and the section intermediate the "break" and the tip had the same modification for increased camber as in the B-26 model [R. 520] for the same reasons and with like result in stall characteristics. The camber of the tip was increased by changing to the section shown in Figure 4 [R. 857] and fairing linearly to the gull break. The camber at the intermediate station between the root section and the tip, deviated from the camber obtainable with straight fairing [R. 525, 587]. This change accomplished the result of shifting the incipient stall point inboard from the tip

THE GLENN L. MARTIN PBM AIRPLANE

APPLIED TO CLAIMS OF GARBELL PATENT IN SUIT

CLAIM 2 A LIFTING SURFACE WITH THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS, IN WHICH

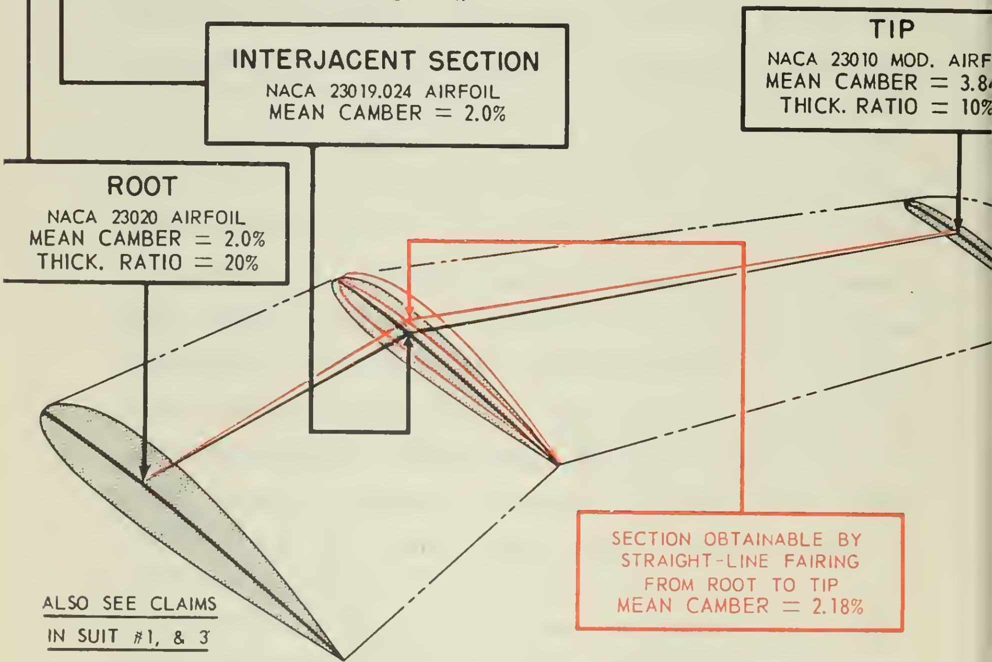
THE FIRST SECTION WITH THE SMALLEST MEAN-LINE CAMBER IS LOCATED AT THE ROOT,

THE SECOND SECTION WITH THE GREATEST MEAN-LINE CAMBER IS LOCATED AT THE FLUID-DYNAMICALLY EFFECTIVE TIP,

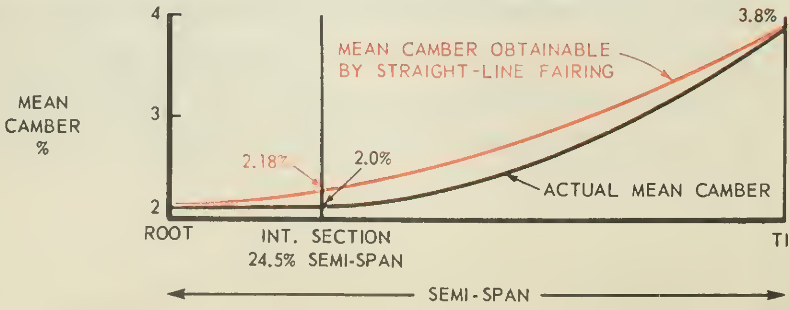
AND THE THIRD OR ADDITIONAL FLUID-FOIL SECTIONS ARE LOCATED AT STATIONS INTERJACENT BETWEEN THE ROOT AND THE TIP, WHEREIN THE VALUES OF THE MEAN-LINE CAMBER OF THE INTERJACENT FLUID-FOIL SECTIONS ARE AT VARIANCE WITH THE VALUES OF THE MEAN-LINE CAMBER OBTAINABLE AT THE RESPECTIVE SPANWISE STATIONS BY MEANS OF STRAIGHT-LINE FAIRING BETWEEN THE FLUID-FOIL SECTION LOCATED AT THE ROOT OF THE LIFTING SURFACE AND THE FLUID-FOIL SECTION LOCATED AT THE TIP OF THE LIFTING SURFACE,

SAID THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS HAVING VALUES OF THE MEAN-LINE CAMBER SELECTED IN SUCH MANNER THAT THE RESULTING SPANWISE DISTRIBUTION OF MAXIMUM ATTAINABLE SECTION LIFT COEFFICIENTS OF THE THREE OR MORE CONTROLLED SECTIONS FORMS A CURVILINEAR POLYGON ENVELOPING A CURVE REPRESENTING THE SPANWISE DISTRIBUTION OF SECTION LIFT COEFFICIENTS FOR A GIVEN PLANFORM ACTUALLY PREVAILING AT THE MAXIMUM ATTAINABLE LIFT COEFFICIENT OF THE LIFTING SURFACE.

REFER TRIMBLE DEPOSITION - R.515



SPANWISE MEAN CAMBER DISTRIBUTION



[R. 589]. This wing had stall characteristics sufficiently satisfactory for use in the 1,300 PBM-3 airplanes that were made and flown.

The Martin PBM-3 airplanes have been established by purchase contract [R. 823]; page W-3 from data book DX-NN [R. 861]; drawing DX-RR [R. 865]; photographs of airplane in flight, DX-QQ [R. 865]; report 1339, DX-II [R. 849], and the testimony of Trimble [R. 519-526], and Clark [R. 586-589] concerning the details of these airplanes, and of Boardley about sales. About 1,300 of these airplanes were built and flown [R. 503-505] during the period 1941-1945.

Here again, as routine engineering procedure, the Martin Company, when confronted with tip stall in an airplane, modified the wing by increasing the camber at the tip, to provide an interjacent section having a mean-line camber "at variance" with linear fairing, to in turn move the point of stall inception inboardly on the wing and provide satisfactory stall characteristics.

On accompanying Plate X, claim 2 of the patent in suit is applied to the Model PBM. There is no difference in the means (camber and thickness ratio) specified, for producing the same result (inboard stall) as the patent. This result was actually achieved in the Martin airplanes.

The proofs of the Martin Models B-26 and PBM have not been challenged by plaintiff. The opinion and Findings of Fact of the District Court do not mention either of these airplanes.

We assert that these Martin airplanes are complete anticipations of the wing construction specified in the claims of the patent in suit.

(e) The Vultee "Vengeance" Airplane.

Another prior-art aircraft embodying the principles of the patent in suit was the "Vengeance" airplane designed and manufactured by Vultee Aircraft, Inc. About 1500 of such aircraft were built and sold to the Army Air Force; contracts dated September 22, 1942, and December 17, 1942, for 400 and 2330, respectively, of such aircraft being in evidence in Defendants' Exhibit K [R. 805, 330-331], and deliveries thereof started in 1942 or 1943 [R. 333].

The "Vengeance" had a wing having three control sections, the root section and the interjacent section having the smallest mean-line camber and the greatest thickness ratio, and the tip section having the greatest mean-line camber and the smallest thickness ratio, the interjacent section having a mean-line camber greater than that obtainable by straight-line fairing and a thickness ratio at variance with that obtainable by straight-line fairing [R. 332-333, 335-341]. The geometry of the "Vengeance" wing is graphically illustrated in Defendants' Exhibit LLL [R. 974], the graph of which is reproduced in accompanying Plate XI.

The root section had the least camber (1.4%), the tip had the greatest camber (2.0%) and the interjacent sta-

THE VULTEE MODEL V72 AIRPLANE

PPLIED AGAINST CLAIMS OF GARBELL PATENT IN SUIT

5 A LIFTING SURFACE WITH THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS, IN WHICH

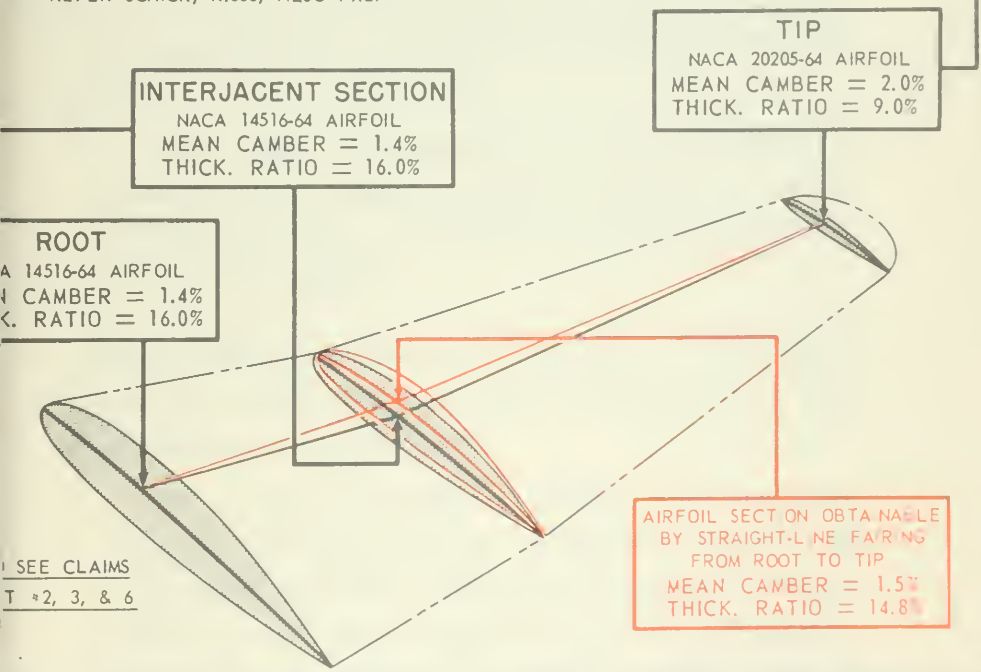
THE FIRST SECTION WITH THE SMALLEST MEAN-LINE CAMBER AND GREATEST THICKNESS RATIO IS LOCATED AT THE ROOT,

THE SECOND SECTION WITH THE GREATEST MEAN-LINE CAMBER AND SMALLEST THICKNESS RATIO IS LOCATED AT THE FLUID-DYNAMICALLY EFFECTIVE TIP,

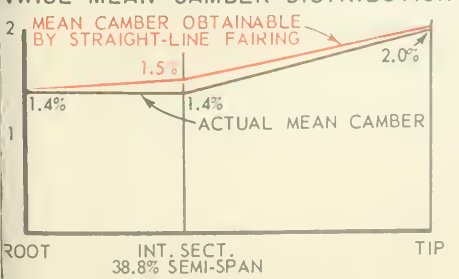
AND THE THIRD OR ADDITIONAL FLUID-FOIL SECTIONS ARE LOCATED AT STATIONS INTERJACENT BETWEEN THE ROOT AND THE TIP, WHEREIN THE VALUES OF THE THICKNESS RATIO OF THE INTERJACENT FLUID-FOIL SECTIONS ARE AT VARIANCE WITH THE VALUES OF THE THICKNESS RATIO OBTAINABLE AT THE RESPECTIVE SPANWISE STATIONS BY MEANS OF STRAIGHT-LINE FAIRING BETWEEN THE FLUID-FOIL SECTION LOCATED AT THE ROOT OF THE LIFTING SURFACE AND THE FLUID-FOIL SECTION LOCATED AT THE TIP OF THE LIFTING SURFACE,

SAID THREE OR MORE CONTROLLED FLUID-FOIL SECTIONS HAVING VALUES OF THE THICKNESS RATIO SELECTED IN SUCH MANNER THAT THE RESULTING SPANWISE DISTRIBUTION OF MAXIMUM ATTAINABLE SECTION LIFT COEFFICIENTS OF THE THREE OR MORE CONTROLLED SECTIONS FORMS A CURVILINEAR POLYGON ENVELOPING A CURVE REPRESENTING THE SPANWISE DISTRIBUTION OF SECTION LIFT COEFFICIENTS FOR A GIVEN PLANFORM ACTUALLY PREVAILING AT THE MAXIMUM ATTAINABLE LIFT COEFFICIENT OF THE LIFTING SURFACE.

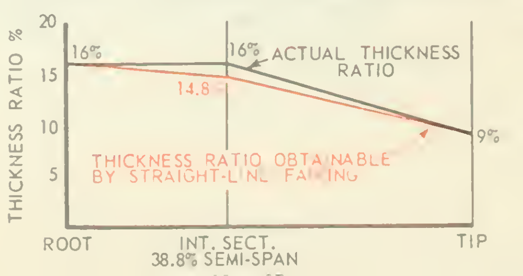
REFER SCHICK, R.333; ALSO PX29



NWISE MEAN CAMBER DISTRIBUTION



SPANWISE THICKNESS RATIO DISTRIBUTION



tion had 1.4% camber which is less than and at variance with that obtainable by straight-line fairing from root to tip. The thickness ratio was 16.0% at the root, 16% at the break or interjacent station, and 9.0% at the tip, as charted in Exhibit LLL [R. 974], and identified and explained by Shick [R. 376]. The thickness ratio at the break was greater than and at variance with that obtainable by straight-line fairing. The interjacent station was located at approximately 40% of the semi-span [R. 819].

This is a wing of the type described in the statement of the patent in suit [Col. 4, lines 51 to 56], which points out an exemplification for achieving the asserted results when—

> "The values of the mean-line camber of the interjacent sections neither exceed the mean-line camber of the tip section nor fall below the mean-line camber of the root section."

Shick actually participated in the flight and wind-tunnel tests of the Vultee airplanes, and, describing their stall characteristics, said [R. 332]:

> "A. Stall characteristics started with an initial stall at approximately the mid-control station, and progressed gradually both spanwise outboard and inboard, in a gradual manner as the stall progressed. It was a mild section stall, mid-section stall. I should say that was verified in flight as in the wind-tunnel tests."

These airplanes embodied the particular spanwise distribution of lift coefficients referred to in the claims of the patent. Shick said [R. 333]:

> "Q. In the Vengeance airplane did the fluidfoil sections have mean line camber that resulted in spanwise distribution of maximum attainable lift coefficients of the three or more control sections forming a curvilinear polygon enveloping a curve representing the spanwise distribution of section lift coefficients? A. It did. It formed a curvilinear polygon.
>
> Q. * * * Does any airfoil which has three-control stations, with the mean line camber at the mid-station at variance with the other two, result in this curvilinear polygon involving a curve representing the spanwise distribution of section lift coefficients? A. Yes sir, it does."

Shick clarified this statement by Plaintiffs' Exhibit 29.

The Vultee airplanes actually achieved these stall characteristics by means of spanwise distribution of camber and thickness. Garbell's patent application was based on theory. The former was an accomplishment and the latter was a prediction.

The opinion of the District Court and Findings of Fact fail to mention the Vultee airplanes, notwithstanding the unchallenged evidence that the wings of that airplane produced a stall which has its inception over an area inboard of the tip and of the lateral control surface, and contained the camber and thickness variations exemplified in the patent.

POINT SIX.

The Claims in Suit Are Fatally Indefinite.

Claim 1 in suit distinguishes from the prior art, if it distinguishes at all, merely in the inclusion of an interjacent fluid-foil section having a mean-line camber "greater" than that obtainable by straight-line fairing. If there be any novelty, it is at this exact point, because the balance of the claim merely defines a conventional wing (p. 9, *supra*). Yet no hint is given either in the claim or in the specification as to *how much* "greater" it may or must be. We suggest that claim 1 is fatally indefinite at the only possible point of novelty, and that this renders the claim invalid under the law. (*See: General Electric Co. v. Wabash Appliance Corp.,* 304 U. S. 364, 58 S. Ct. 899, 82 L. Ed. 1402 (1938); *United Carbon Co. v. Binney & Smith Co.,* 317 U. S. 228, 63 S. Ct. 165, 87 L. Ed. 232 (1942).)

Claims 2 and 3 are subject to the same vice, but in a more exaggerated way. These claims define the mean-line camber of the interjacent section merely as "at variance" with that obtainable by straight-line fairing. Although this is the only conceivable point of novelty in these claims, they fail to state *what* or *how much,* this "variance" is to be.

Claims 5 and 6 do not define the mean-line camber of the interjacent section at all, and if this is in fact essential to the alleged invention these claims are fatally incomplete. Furthermore, while these claims define the thickness ratio of the interjacent section as "at variance" with that obtainable by straight-line fairing, they do not define *what* or *how much* this "variance" may or must be, nor does the specification do so.

Similarly, claim 12 fails to define the mean-line camber of the interjacent section, and defines its thickness ratio merely as "smaller" than that obtainable by straight-line fairing. How much smaller is left wholly in doubt, and there is nothing in the specification to assist in determining this.

We therefore submit that Findings XXII, XXIV and XXIX are clearly erroneous, and that all of the claims in suit should be held invalid for failing to "particularly point out and distinctly claim" the alleged invention as required by Section 33, Title 35, U. S. C. A.

POINT SEVEN.

Defendants' Airplanes Do Not Produce the Type of Stall Described in the Patent in Suit and Do Not Infringe.

(a) The Model 240 Airplane.

The wing illustrated and described in the Garbell patent is bare and devoid of the environmental structure or concomitants of the actual wing of a multi-engine airplane, such as fuselage, engine nacelles, control surfaces and a tail structure or empennage. The interjacent station with camber variation is located at 55% [Col. 8, line 58] of the semi-span from the root with no washout, or at 60% of the semi-span [Col. 8, line 71] from the root with 0.5 aerodynamic washout. The spanwise relation of the inner ends of the ailerons and the tail surfaces of the airplane to the interjacent station are not illustrated or described.

The wing of defendants' accused Model 240 Convair airplane has an engine nacelle and an aerodynamic washout or twist of 1° 12′ [R. 1005]. There is a very slight deviation in camber and thickness from linear fairing at the 30.7% station from the root, which is referred to as a "break." The upper and lower surfaces of the wing, for an area of approximately 5 feet spanwise, are enclosed in the nacelle and are not in contact with the air stream during flight. Fillets between the root and the fuselage were added according to the flight reports [PX-35], and modifications to the fillet at the after end of the nacelle and to the control system [R. 418] were made without changes in the wing sections, *per se*. These were made to correct unfavorable stall characteristics which were evident in the first model of the 240 series, and resulted in the ultimate stall characteristics of the accused airplanes. In agreement that these additions and modifications are important factors in the aerodynamic or stall characteristics and results are Garbell [R. 272] and the engineers Ward [R. 419] and Trimble [R. 570-574].

(b) Stall Characteristics or Operation and Results.

It is elementary that substantial identity in operation and result must be established to prove infringement, as well as identity in means. In the instant case, that means identity in the particular stall characteristics produced by the wing of the patent and the wing of defendants' Model 240 airplane. (*See: Sewall v. Jones,* 91 U. S. 171, 23 L. Ed. 275; *Riverside Heights Orange Growers Assn. v. Stabler,* 240 Fed. 703 (C. A. 9).)

In an airplane, the stall characteristics reflect the mode of operation and results of the wing.

In the patent, the interjacent control station is described as being located 55% of the semi-span outboard from the root [Col. 8, line 58]. The stall inception and development or spread is illustrated in Figure 3 and described in Column 5, lines 39-43. The stall inception is in the area *12,* and spreads progressively inwardly and outboardly to the areas *13, 14, 15* and *16* from the inception area *12,* at angles of attack greater than that at which stall inception occurs. The prevalent development or spread *after* inception is inboard, and it is this spread which Garbell described for producing the tail shake for a stall warning [Col. 8, line 51]. For this operation and result, the area *12* of stall inception must be outward (spanwise) of the outer end of the tail of the airplane and the root or fuselage, as is indicated in Figure 3, so that the air flow aft from the wing to the tail will be retained during the stall inception to prevent tail shake. The development or spread from the inception area *12* must be inward toward the root as the angle of attack is increased in approaching a full stall. The spread of the stall must be toward the root area in front of the tail to produce the delayed tail shake. While the spread from inception area *12* is predominantly inward, it also develops outwardly therefrom in the results illustrated and described. Those are the stall characteristics or operation and result described in the patent in suit.

In describing the stall of the wing of the patent in suit, Garbell said [R. 183]:

> "In effect, it was the idea of having stall inception that is the first separation of the air flow over some section of the wing, *out*side of the tail. Somewhere, let's say in the vicinity of the mid-span or somewhat inboard of it, so that the *first* separation would *not* produce a tail shake; and then design the wing so that stall separation would move rapidly inboard and less rapidly *out*board, so that it would reach the root

> within a few degrees of angle of incidence so that there would be a shake at the tail before the lift was completely lost." (Italics added.)

For that result, the stall inception area must be *out*ward spanwise from the tail and spaced spanwise from the root and progress inward or spread toward the root. There must be an initially non-stalled area near the root in order to avoid the initial tail shake.

In describing "root" stall and differentiating it from the stall of the patent, Garbell said [R. 179]:

> "Now, this proposed root stall is to start on the wing near the wing root, or at the wing root, and is to develop quite deeply in the wing root panel with a very slow and gradual progression outward as the angle of attack increases * * * The first consequence of a root stall is a vigorous tail shake."

The essential difference in result asserted by Garbell between the old "root" stall, and that in the patent, is that "root" stall produces a tail shake at the *in*ception while the wing of the patent does not produce it at inception but defers it until just before the angle of attack is increased to the full stall point.

The District Court held [R. 38] that Garbell's patent teaches a wing "having a stall which has its inception over a large area inboard of the lateral control surface (aileron) that spreads inwardly." That is not in agreement with the illustration and description in the patent, where the area of inception indicated at *12* is not "over a large area," but a very restricted area between the outer end of the tail (not shown) and the inner end of the aileron (not shown), if we assume that area *12* is located to avoid an initial tail shake. It is the spread which may be over a large area, but not the inception. Likewise, Findings VII, XI and XII which refer to a stall "which had its inception over a large inboard area" are not in accord with the small inception area (12) illustrated and described. Likewise, Findings XIX and XX, which state that "inducing a stall" (XIX) or "inducing the initial stall" (XX) in an interjacent surface or section "over a wide area" are not correctly descriptive for comparison of the patent and the prior art. Stall inception over a large area is contradictory of the patent because a restricted inception area (12) is essential to prevent the initial tail shake.

The only testimony offered by plaintiffs on the question of infringement was that of Garbell. On *prima facie,* he merely pointed [R. 222] to the camber and thickness variations in the wing of defendants' airplane which are definitely fixed from the evidence [R. 1000]. He did not at all then attempt to explain its stall characteristics.

Ward was completely familiar with the Model 240 airplane and had witnessed flight and wind-tunnel tests with tufts on the wings, as well as the development of the Model 240 from its first design, known as Model 110. Describing the operation and stall demonstrated in flight, he said [R. 419]:

> "Q. Can you tell us from the flight tests where the stall is initiated in the 240 airplanes? A. In

the wing between the nacelle and the fuselage. That is, it is a root stall.

Q. That was based on the tests that you know of? A. Based on flight tests of which I witnessed the tufts of (on) the wings that were installed."

Test and flight reports of the Model 240 are in evidence as Plaintiffs' Exhibit 35, and excerpts are reproduced [R. 110-122, 129-132]. The photographs and reports show that the initial stall occurs suddenly in the root panel on either wing between the nacelle and the fuselage at an angle of attack of approximately 11° [R. 92, 103, 104]. As the angle of attack is increased to 13°, the stall area spreads in the root panel and a secondary stall area is produced outboard of the nacelle. Since the inception area lies in front of the horizontal tail or stabilizer [R. 1000], the tail shake, if there is any, is induced at the inception of the stall for a stall warning [R. 126]. It is a root stall which conforms to Garbell's definition of such [R. 179].

Garbell had no actual knowledge of any tests or operations in flight with defendants' airplane [R. 274]. He did not attempt to point out in the flight reports which defendants furnished to him any support for his testimony.

On rebuttal, after Ward had testified about the root stall in defendants' wing, Garbell said [R. 442]:

"They disclose the stall inception and spread over a large inboard area, both between the ailerons and the nacelles, and the nacelles and root."

That is all he said about stall inception and progression in defendants' wing, and it is misleading. The entire *inception* is between the root and the nacelle and none between the ailerons and the nacelle. The *spread* is outboard to a secondary area outboard of the nacelle. There is no inward progression at any time. Garbell said [R. 179]: "The 'root' stall initially produces a vigorous tail shake." Defendants' wing produces stall inception between the root and nacelle and in front of the tail. Stall inception between the nacelle and root in defendants' wing must produce a tail shake as its first consequence, if it produces any at all, or at any time. That is not the character of the stall the District Court and Garbell ascribed as essential in the patent in suit. There is not one word in the testimony of Garbell or other evidence for plaintiffs that a tail shake is produced, or when it might occur in defendants' wing. Garbell's testimony about defendants' airplane does not mention the operation and result described in the patent—stall inception near the center of the semi-span without tail shake, and inward spread to produce that shake for a deferred stall warning—in defendants' wing. That being the only testimony on this point offered by plaintiffs, we contend that plaintiffs have not proved the identity in mode of operation and result necessary to prove infringement. Stall inception outward of the tail to initially prevent a tail shake until further increase in angle of attack, and subsequent spread of the stall toward the root as described in the patent, is an essential of the mode of operation and result of the patent and is *not* achieved in defendants' wing. There is no infringement.

When plaintiffs asserted, and as the District Court held, that stall characteristics are essential to the patent, the burden devolved upon plaintiffs to prove that those same characteristics are produced by defendants' wing. Plaintiffs have nowhere adduced any proof or attempted to prove (and could not, because it is not the fact) that the stall inception produced in defendants' wing is where it is in the patent—outboard of the tail—to avoid initial stall warning, or that the spread of the stall in defendants' wing is as it is in the patent—inboard toward the root—to produce a delayed tail shake when a complete loss of lift is approached. Therefore, we contend plaintiffs have not proved infringement.

Infringement is not proved by merely reading a claim upon an accused device; the accused device must be clearly shown to have the *same mode of operation*. (*See: McRoskey v. Braun Mattress Co.,* 107 F. 2d 143 (C. C. A. 9th); *Grant v. Koppl,* 99 F. 2d 106 (C. C. A. 9th).) And the burden of proving such infringement rests squarely upon the plaintiff. (*See: Magnavox Co. v. Hart and Reno,* 73 F. 2d 433, 434 (C. C. A. 9th).)

It will therefore be plain that not only did plaintiffs fail to carry their burden of proving infringement, but the only evidence on the question plainly establishes that the accused Model 240 airplane has a different mode of operation in its stall inception and progression, and does not infringe the patent in suit.

POINT EIGHT.

The District Court Erred in Failing to Grant Defendants' Motion for a New Trial.

Although the granting of a motion for a new trial is clearly within the discretion of a trial court, it is submitted that in the present case the District Court abused its discretion in denying defendants' motion.

Two grounds were and are urged in support of defendants' motion: (a) surprise at the trial, which ordinary prudence could not have guarded against; and (b) newly discovered evidence [R. 65].

At the trial, Garbell testified that prior to his employment by defendant Consolidated he had disclosed the alleged invention of the patent in suit to a Dr. Platt [R. 199-202] and to one Chin [R. 202-207], and, apparently accepting such uncorroborated testimony of a biased witness at face value, the District Court found [Finding XXXVI] that Garbell had "fully and completely disclosed his invention to others prior to his employment by Consolidated" [R. 53]. Platt had died prior to trial, and prior to Garbell's testimony defendants had never heard of Chin [R. 71]. Checking with Chin on Garbell's story after the trial, defendants learned that Garbell's testimony as to such disclosures to Chin were made up out of the whole cloth, and defendants submitted Chin's affidavit [R. 66] which completely refutes Garbell's testimony.

Similarly, Garbell testified at length to disclosures made to and statements made by T. P. Hall and D. A. Hall during his employment by Consolidated. Neither of these men was employed by defendant Consolidated at the time of trial, and Garbell's testimony with regard to such disclosures could not be conveniently checked during the trial. Their testimony [R. 75-89] was offered in support of defendants' motion to wholly refute this portion of Garbell's testimony, but was refused by the District Court.

In particular, the testimony of said T. P. Hall was offered to correct the erroneous interpretation put by the District Court upon Plaintiffs' Exhibit 25 [Memorandum Decision, R. 40-41] which obviously greatly influenced the decision on the license issues. The surprise here, obviously, came from the District Court's unexpected and erroneous interpretation of this exhibit, as is shown by Hall's proffered testimony [R. 75], which certainly could not have been anticipated by defendants.

Lastly, the District Court found infringement, stating that defendants had offered no evidence to show lack of infringement [Memorandum Decision, R. 38], and making a finding to this effect [Finding XXXI]. We suggest that the error in this lay in the District Court's erroneous impression that plaintiffs, as a matter of law, had carried their burden of proof of infringement even though there was no evidence that defendants' accused airplane had a stall which initiated inboardly of the tip and then progressed inboardly (which the District Court attributed to the patent in suit), and that the burden of proof had shifted to defendants to negative an issue not established by plaintiffs. When this error of law became apparent from the District Court's memorandum decision, the testimony of Matteson and Fox was offered to show conclusively that defendants' accused airplane in fact has a type of stall entirely different from that of the patent in suit. The District Court refused to receive such evidence.

We submit that defendants were wholly surprised by Garbell's unexpected testimony and by the District Court's erroneous interpretation of the evidence, and that defendants should, in the interests of justice, have been afforded the opportunity to present such proffered testimony. Even though such additional evidence would not have changed the District Court's mind as to the result [R. 496-497], we suggest that such evidence might be more persuasive in this Court.

VI.

Conclusion.

In summary, the pattern of this case is plainly as follows: The patentee Garbell employed the principles of the patent in suit as early as 1937 in his "Pinguino" sailplane; he was employed by defendant Consolidated from August, 1942, until October, 1945, as an aerodynamic engineer, whose duty it was to design and develop airfoils for defendant's airplanes; and during such employment suggested many times to defendant that such "Pinguino" principles be embodied in defendant's airplanes in the process of design. Pursuant to Garbell's suggestion and under his direction, such principles were in fact incorporated in the design of Consolidated's Two-Engine Tailless airplane, its Model 107, its XB-46 Bomber, and its Model 110 (which had the same wing geometry as the accused airplane in suit). During his employment, Garbell made an "official disclosure of invention" to defendant Consolidated of the conception of the patent in suit under his Invention Agreement which provided to defendant an express "free shop-right" thereon. Apart from this express license, defendant Consolidated acquired an implied-in-law license to use the alleged invention, by reason of the fact that Garbell repeatedly suggested its use by Consolidated, which was accepted by defendant pursuant to his suggestions and with his full approval and co-operation, defendant embodying the suggestion in at least four of its aircraft designs. To now deny to defendant Consolidated the free continued use of that which it bought and paid for through extended experimental work and salary to Garbell, extending over a period of several years, would, we suggest, be an affront to good conscience. During his employ by Consolidated, Garbell never asserted any independent or adverse right to the alleged invention in suit, nor did he ever treat it other than as a development made, perfected, and used for and by defendant. Far from being subject to criticism, we suggest that defendant Consolidated has treated Garbell in the highest of good faith and with great liberality, allowing him to retain title to his alleged invention, whereas it could, legally and morally, have compelled him to assign all of his rights to the defendant. We suggest that the employer-employee relationship is a two-way street, and that an employer is as much to be protected by the courts against an unscrupulous employee as the reverse.

The claims of the patent in suit are obviously invalid as lacking novelty over the prior art, every element of each of the claims being found in the same combination in one or more of the prior-art airplanes or publications.

Even if there is some vestige of novelty in the claims, it does not rise to the dignity of invention, but constitutes mere mechanical skill of the calling. Each of the claims in suit is merely for a collection of old airfoil sections, the novelty, if any, residing in the selection defined thereby. It was old in the art to provide aircraft wings having three or more control sections, in which the mean-line camber increases and the thickness ratio decreases from root to tip, and providing an interjacent section between root and tip which has a mean-line camber and thickness ratio "at variance" with that obtainable by straight-line fairing, to avoid tip stall by moving the point of stall inception inwardly from the tip. Any variations from such art which plaintiffs can point to in the claims in suit constitute mere changes in form and degree, and do not provide any result new, unexpected, or differing in kind. All of the claims in suit are therefore clearly invalid as mere aggregations of old elements.

Lastly, it is submitted that the claims are so vague and nebulous as to be fatally indefinite and therefore void as failing to comply with 35 U. S. C. A., Section 33. Each of such claims is wholly indefinite at the exact point of novelty asserted by the patent, *i. e.,* in defining the interjacent section as having mean-line camber or thickness ratio "at variance with" or "greater than" or "less than" that obtainable by straight-line fairing.

It is respectfully submitted that the judgment of the District Court should be reversed *in toto,* and the action dismissed.

Dated December 29, 1951.

Respectfully submitted,

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APPENDIX A.

APPENDIX A.

The Conventional Aircraft Wing.

While aircraft wings have been made in many configurations, a typical conventional wing is illustrated in Plate I, page 9 of the foregoing brief, for reference in connection with the following glossary:

Plate 1, Fig. 1, is a plan or top view of a conventional two-engine airplane showing its essential components.

Fig. 2 is an enlarged plan or top view of one semi-span of the aircraft shown in Fig. 1, omitting the engine nacelle for clarity.

Fig. 3 is a front view of the semi-span shown in Fig. 2.

Fig. 4 is a cross section of the semi-span on line AA of Fig. 2.

Each of the cross sections through an aircraft wing is termed an *airfoil section* or *profile.* In addition to the area and shape of a wing, the selection of the airfoil sections from which the wing contours are derived determines its aerodynamic characteristics. There is a wide diversity of airfoil sections known and used in the design of aircraft, a number of which are shown in Defendants' Ex. VVV. Generally speaking, the upper contour of an airfoil section or its *upper camber* is convex, while its lower contour or *lower camber* is straight or slightly concave, the two contours being joined to form a *leading edge* by means of a *leading edge radius,* and converging to a relatively sharp *trailing edge.* The flow of air over the upper and lower contours of an airfoil section creates a pressure differential which results in the ability of the section to develop a lifting force when inclined upwardly in an airstream.

In an airfoil section, the median line between the upper and lower cambers gives a curve which is called the *mean-line camber.* The maximum height of the mean-line camber above a straight line joining the leading and trailing edges (*the chord*) divided by the chord is the *mean-line camber ratio* which is usually expressed as a percentage.

In the conventional aircraft wing shown in Plate I, the taper from root to tip is uniform, *i. e.,* straight lines connect the fluid-foil section at the root of the semi-span (*i. e.,* the *root section*) with the fluid-foil section at the wing tip (*i. e.,* the *tip section*). For the purposes of this case, such uniform taper between root and tip is referred to in the evidence as *straight-line fairing or lineal fairing.* Such *lineal* or *straight-line fairing* may be between any two fluid-foil sections of the wing, *e. g.,* between root and tip, as shown in Plate I, or between any two intermediate or *interjacent* sections.

Plate II, bound opposite page 9 of the brief, will assist in an explanation of the meaning of *"stall"* in an airplane wing. The upper figure thereof shows a section taken through a conventional wing in flight, the air flow over and under the wing being illustrated by lines. In Fig. 1, the chord line of the wing is substantially horizontal and the direction of the air stream is indicated by the arrow. As will be noted, there is a substantially clean separtion of the air at the leading edge, and a smooth flow of air over and under the wing, which is essential to produce lift.

If the nose of the airplane is directed upwardly, the wing may take the position indicated in the middle figure, in which the chord line of the wing makes a substantial angle with the horizontal line, which angle is the *angle of attack.* As illustrated, the air-flow lines still show a clean separation at the leading edge and a smooth flow over most of the wing. At the rear of the wing, however, on its upper surface, the clean air flow has separated from the wing, causing an area of air turbulence, indicated as "stalled area." Due to this turbulence, there is little or no aerodynamic lift over the "stalled area." There is sufficient aerodynamic lift over the balance of the surface of the wing, however, to insure substantially normal flight of the airplane.

As the angle of attack is increased to a position as shown in the lower figure, the air separation ("stalled area") likewise increases and the lift decreases until such time as the total wing lift is insufficient to support the aircraft in the air, at which time the craft falls, normally going into a dive with the nose down. The point at which the aircraft starts to fall is actually the *stall point,* but prior thereto there may be stall areas on the upper surface of the wing due to such air separation.

Adjacent the wing tips of a conventional airplane, *ailerons* are normally provided on the trailing edge of the wing, which are used to control flight. If a substantial part of the aileron area of the wing is stalled, due to a substantial increase in the angle of attack of the airplane, it may be impossible to control flight, as the ailerons may then become ineffective, and this unfavorable condition is known as *tip stall.*

Glossary.

Aileron: A hinged or movable portion of the trailing edge of an airplane wing for controlling the lateral motion of the airplane.

Airfoil: A surface or aircraft component, such as an airplane wing, aileron, rudder, elevator, designed and intended to react with an air stream to produce lift.

Airfoil Section: A transverse section through a wing.

Angle of Attack: The angle between the chord of an airfoil section and the relative air stream.

Camber: The rise of the contours of an airfoil section from the chord; usually expressed as the ratio of the departure of the curve from the chord to the length of the chord.

Chord: An arbitrary datum line from which the ordinates and angles of an airfoil section are measured; the straight line between the leading and trailing edges.

Drag: The combination of the total air force on a body parellel to the relative wing.

Fairing: Structural shape, cowl, or covering to house an irregularity in order to reduce drag.

Flaps: A pivoted airfoil usually at the trailing edge of the wing near the fuselage used to vary the effective camber.

Fuselage: The body to which the wings and tail of an airplane are attached.

Interjacent Station: A spanwise section between the root section and tip section of a wing.

Leading Edge: The foremost edge of an airfoil with reference to its direction of movement through the air.

Lift Coefficient: An arbitrary function denoting the degree of lift force obtainable from an airfoil or airfoil section under a given set of conditions.

Mach Number: The ratio of the velocity of an airfoil in flight to the speed in sound.

Maximum Thickness: The greatest thickness of the airfoil section measured or a line maximum to the chord and is usually expressed as a per cent of the chord length.

Mean-Line Camber: The rise of the median line between the upper and lower contours of an airfoil section from the chord, usually expressed as the ratio of the maximum amount of departure from the chord of the section to the length of the chord.

Nacelle: A fairing, usually to enclose a power plant.

Planform Taper: A change in chord length along the wing span from the root to the tip, usually expressed in the ratio of the root chord to the tip chord, such as 3 to 1.

Reynolds No.: A non-dimensional coefficient used as a measure of the dynamic scale of a flow.

Root (Wing): The inboard end of the wing adjoining the fuselage.

Semi-span: The maximum distance between the center-line of the fuselage and the wing tip.

Span: The maximum distance from wing tip to wing tip of an airplane.

Stall: The condition of an airfoil or airplane in which it operates at an angle of attack greater than the angle of attack of maximum lift.

Tail: The rear components of an airplane usually consisting of a system of horizontal and vertical stabilizing planes or fins to which movable control surfaces are mounted such as elevators and rudders.

Tip (Wing): The outer end of an airplane wing.

Thickness Ratio: The ratio of the thickness of an airfoil section to the length of the chord; usually to denote the ratio of the maximum thickness of the section to the chord length.

Trailing Edge: The rearmost edge of an airfoil with reference to the direction of movement through the air.

Wing: An airfoil designed primarily to produce the lift force necessary to sustain an airplane in flight.

APPENDIX B.

APPENDIX B.

". . . However, an anticipating fact [Dunn's application] prior to the date of Anderson's application was proved beyond a reasonable doubt, thereby shifting the burden of proof to the plaintiff to prove, by a preponderance of the evidence, that his invention was made still earlier than when that fact occurred. *It is elementary in patent law that an invention is not complete until it is 'reduced to practice.'* An application for a patent is equivalent to a reduction to practice, designated by the courts for convenience as 'constructive reduction to practice.' However, when in a case like the one under consideration it is desired to carry the date of invention back of the date of application, *earlier actual reduction to practice is required to be proved.*

"It will be noted that the entire evidence presented in support of plaintiff's claim consisted of the oral testimony of Anderson and Dunn, above outlined, and the sketch which Anderson claimed he made about the time of his claimed conception of the invention. This sketch cannot be said in any sense to prove a reduction to practice, . . ." [Emphasis added.]

Hann v. Venetian Blind Corp., 111 F. (2d) 455, at 458 (1940).

". . . No formal granting of a license is necessary in order to give it effect. Any language used by the owner of the patent or any conduct on his part exhibited to another, from which that other may properly infer that the owner consents to his use of the patent in making or using it, or selling it, upon which the other acts, constitutes a license and a defense to an action for a tort . . ."

De Forest Radio Telephone & Telegraph Co. v. United States, 273 U. S. 236, 71 L. Ed. 625.

"While it is true that the invention was made before Lawson, one of the inventors, became connected with appellee, yet it was Lawson, as one of appellee's stockholders and officers, and as a superintendent of manufacture, who expended much of appellee's time and considerable of its money in adapting the invention to practical use in appellee's business. The experimentation and expense proceeded during the two years of his association with appellee. If at that time his efforts had been attended with success, and a considerable trade established in gloves made under that patent, it would scarcely be questioned that a shop right accrued to appellee.

"If the final step which led to a successful application of the patent to appellee's business was not taken until after Lawson's relations with appellee had ceased, should appellee be held thereby to have lost the benefit of its previous expenditures and efforts to that end under the patentee's direction? We think not, but rather that, in fairness, they were authorized to continue to make available to them the investment and experimentation theretofore made with Lawson's direction and co-operation in the undertaking to employ his invention in the joint enterprise of himself and the others interested in appellee corporation."

Elzilaw Co. v. Knoxville Glove Co., 22 F. (2d) 962 (C. C. A. 2d, 1927).

". . . The George invention, if any was disclosed in his crude model, was an inadequate conception, which had never been embodied in a machine. It was uncertain whether he would or could obtain a patent. He presented it to his employer, and allowed his employer to risk a substantial investment in constructing machinery and bringing it into practical use, without any suggestion that, if these efforts proved successful, the employer would be required to pay toll for the use of the invention thus perfected.

"The sense of justice underlying the equities of such a situation was emphasized by Dickinson, District Judge, in Mix v. National Envelope Co. (D. C.), 244 F. 822. The license to be implied should be coextensive with the employer's business requirements, because the obvious purpose with which invention and investment were made was to satisfy those requirements, and if the scope of the license was to be less than the breadth of this purpose it was the duty of the employee to say so. No formal granting of a license was necessary. Silence, under all the circumstances, was sufficient to give effect to a license commensurate with the obvious purpose of the parties . . . " (pp. 1007, 1008).

> *Tin Decorating Co. v. Metal Package Corp.*, 29 F. (2d) 1006 (aff'd 37 F. (2d) 5, and cert. denied).

" 'The doctrine of the shop right is of equitable origin. The principle involved is that where an inventor or owner of an invention acquiesces in the use of the invention by another, particularly where he induces and assists in such use without demand for compensation or other notice of restriction of the right to continue, he will be deemed to have vested the user with an irrevocable, equitable license to use the invention. This situation between the inventor and employer might, of course, arise by mutual agreement, but generally the situation arises where the inventor induces his employer to proceed and not only fails to object to the use, but stands by or assists, while permitting his employer to assume expense and put himself in a position where it would be to his detriment to be compelled to relinquish further use of the invention.' "

Gate-Way v. Hillgren, 82 F. Supp. 546 (D. C. Calif. 1949, aff'd 181 F. (2d) 1010).

"While the evidence shows that the invention was discussed at various times with various executives of the defendants, not only did they not assert any right thereto, but *from the very beginning they considered it impractical,* and so stated to the plaintiff. And, in one instance, at least, the statement of impracticability was admittedly stated in not very genteel language. The fullest disclosure of the patent invention made *to the head of the defendants' Patent Department, on March 2, 1945,* and passed through channels, *bears the final rejection* in a pencilled notation, 'Not (interested) at this time.' [Plaintiff's Exhibit 25.] And that notation, like the 'damned spot' in Macbeth, will not 'out,' for all adjurations. *For it spells rejection* of the invention, . . ." [Emphasis added.]

Memorandum Decision [R. 40-43].

"There remains the question as to whether Appel's device does anticipate appellee's device. The differences between the two devices, as stated above and as related by witness McDougall, are in the form or shape of such devices. Are the changes in Appel's device made by appellee sufficient to impart invention to appellee's device? We think not. The rule on that point is an aged one, and is stated in Smith v. Nichols, 21 Wall. 112, 88 U. S. 112, 119, 22 L. Ed. 566, as follows: '* * * But a mere carrying forward or new or more extended application of the original thought, a change only in form, proportions, or degree, the substitution of equivalents, doing substantially the same thing in the same way by substantially the same means with better results, is not such invention as will sustain a patent. * * *'

* * * * * * * * *

"Here, the most that can be said for appellee's device is that appellee extended the application of Appel's device, and changes in the form thereof. The two devices do the same thing, *i. e.,* prevent wear of the housing. They do it in the same way, *i. e.,* by causing the wear to be absorbed by the liner instead of the housing. Are substantially the same means used? We think they are . . ."

Bingham Pump Co., Inc. v. Edwards, 118 F. (2d) 338 (1941), at 340.

". . . There is no exact standard by which a court may determine when a combination of old elements constitutes invention and when it is within the mechanical skill of one working in the art. The most recent opinion of the Supreme Court on combination patents expresses the view that, 'courts should scrutinize combination patent claims with a care proportioned to the difficulty and improbability of finding invention in an assembly of old elements.' Great Atlantic & Pacific Tea Co. v. Supermarket Equipment Corp., 340 U. S. 147 [87 U. S. P. Q. 303, 306]. The test to be applied to such patents is that the combination must perform some new or different function—one that has unusual or surprising consequences. It is our view that the patent in suit fails to meet this severe test and does not constitute invention. The most that can be said for the patent in suit is that it rearranges the elements of the slit camera in such a manner that in the performance of their respective functions a higher degree of accuracy is obtained . . ."

Photochart v. Photo Patrol, Inc., 189 F. (2d) 625 (1951).

APPENDIX C.

Feb. 21, 1950 M. A. GARBELL 2,498,262

FLUID FOIL LIFTING SURFACE

Filed Sept. 16, 1946 3 Sheets-Sheet 1

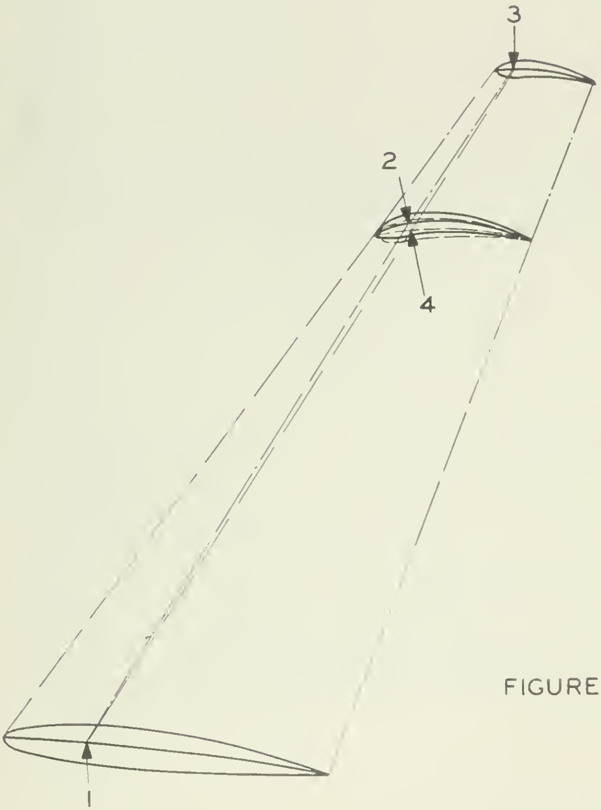

FIGURE 1

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Feb. 21, 1950

M. A. GARBELL

FLUID FOIL LIFTING SURFACE

2,498,262

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3 Sheets-Sheet 2

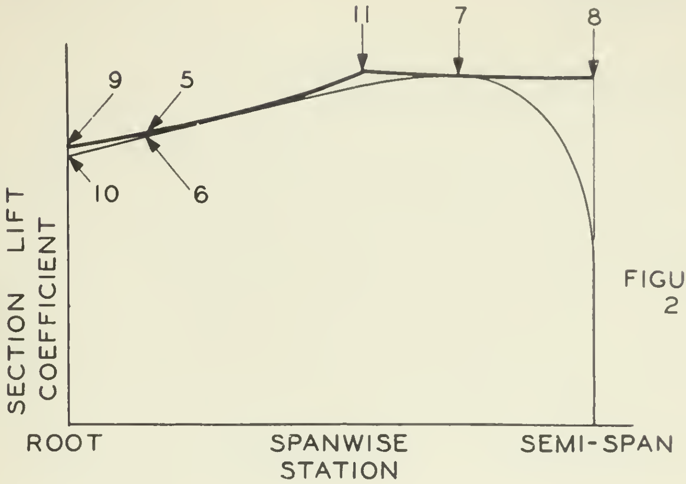

FIGURE 2

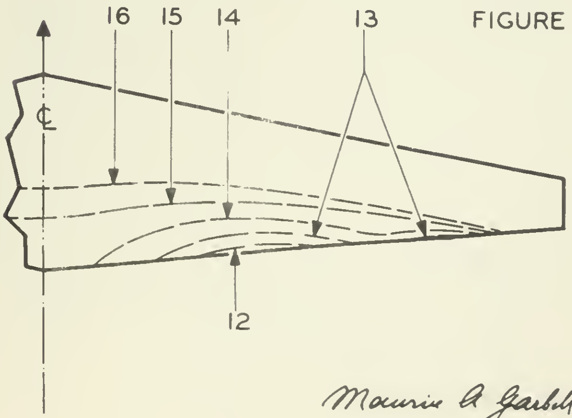

FIGURE 3

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FLUID FOIL LIFTING SURFACE

Filed Sept. 16, 1946 3 Sheets-Sheet 3

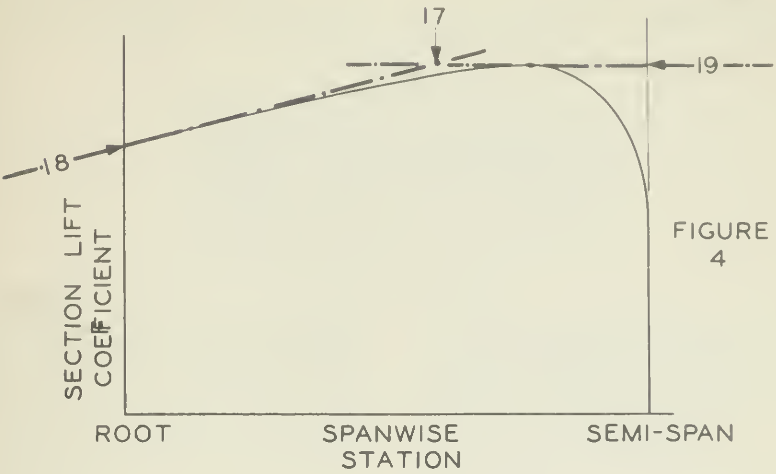

FIGURE 4

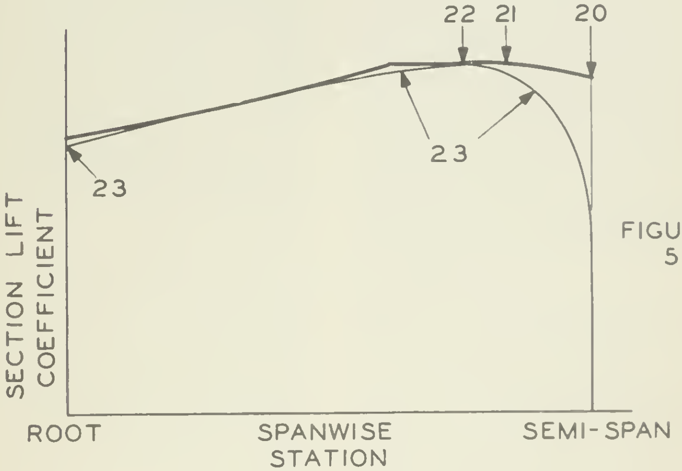

FIGURE 5

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Patented Feb. 21, 1950 2,498,262

UNITED STATES PATENT OFFICE

2,498,262

FLUID FOIL LIFTING SURFACE

Maurice A. Garbell, San Francisco, Calif., assignor, by direct and mesne assignments, of one-fourth to Maurice A. Garbell, Inc., San Francisco, Calif., a corporation of California, and three-fourths to Garbell Research Foundation, San Francisco, Calif., a corporation of California

Application September 16, 1946, Serial No. 697,281

12 Claims. (Cl. 244—35)

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This invention relates to the design and construction of surfaces to be driven through a fluid, and in particular through the air, intended to produce a useful force component perpendicular to the relative velocity of the fluid with respect to the surface; the said useful force component will be referred to hereinafter as "lift," and the said surfaces will be referred to hereinafter as "lifting surfaces."

The present application is a continuation in part of my co-pending application entitled Fluid foil lifting surface, Serial Number 683,815, filed on July 16, 1946, now Patent No. 2,441,758 of May 18, 1948, the general object of which is the attainment of good stalling characteristics on lifting surfaces by means of a novel method of fluid-foil selection, wherein the mean-line camber and if necessary the thickness ratio of one or more fluid-foil sections interjacent between the root and the tip of the lifting surface are varied from the respective values obtainable by straight-line fairing between the root and tip sections by following the subject method of the said co-pending application.

The general objects of the invention specified in the instant application are the attainment of good stalling characteristics, the elimination of violent rolling moments, the creation of stable nose-down pitching moments at the stall, the maintenance of adequate lateral-control effectiveness, the reduction of the fluid-dynamic drag, and a reduction of the resulting drag moment with respect to the root of the lifting surface.

Another object of the invention specified in the instant application is the attainment of especially high lifting-surface lift coefficients in those designs in which engineering considerations other than those pertaining solely to the control of stalling characteristics permit the fluid-dynamical design engineer to utilize interjacent fluid-foil sections having a mean-line camber greater than the mean-line camber of the section at the root or the section at the tip of the lifting surface, wherein the spanwise location, mean-line camber, and thickness ratio of the said interjacent fluid-foil sections are defined and explained in the subject specification of this invention.

Other objects and advantages will be apparent from an examination of the drawings accompanying the instant application taken in conjunction with the following, and in which:

Figure 1 shows a schematic perspective view of a lifting surface designed and constructed according to the method outlined in the subject specification.

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Figure 2 illustrates the spanwise distribution of actually prevailing section lift coefficients and the spanwise distribution of maximum attainable section lift coefficients on a typical lifting surface designed and constructed according to the subject method of this invention.

Figure 3 illustrates the typical inception and growth of the stall of a lifting surface designed and constructed according to the subject method of this invention.

Figure 4 illustrates the procedure employed in the finding of the optimum spanwise location of the third controlled fluid-foil section in a lifting surface designed and constructed according to the subject method of this invention.

Figure 5 illustrates the spanwise distribution of actually prevailing section lift coefficients and the spanwise distribution of maximum attainable section lift coefficients on a typical lifting surface designed and constructed according to the subject method of this invention, the tip section of said lifting surface having a thickness ratio smaller than the optimum thickness ratio for absolutely maximum attainable section lift coefficient for the series of fluid-foil sections employed in the lifting surface.

A preferred embodiment of this invention is described in the following specification; the broad scope of the invention is expressed in the claims concluding the instant application.

The invention consists of novel methods and combinations of methods described hereinafter, all of which contribute to produce a safe and efficient lifting surface.

Referring to the drawings for more specific details of the invention, Figure 1 serves to illustrate the preferred embodiment of this invention, comprising a lifting surface with three or more "controlled" fluid-foil sections, in which a section with a small mean-line camber 1 is located at the root of the lifting surface, a section with a greater mean-line camber 3 is located at the fluid-dynamically effective tip of the lifting surface (the actual tip fairing of the lifting surface may comprise a faired three-dimensional body without identifiable mean-line camber, which is not of any consequence in the application of the subject invention), and one or more interjacent sections 2 are selected following the method outlined below, said interjacent fluid-foil sections having values of the mean-line camber at variance with the values 4 obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root and the fluid-foil section located at the tip of the lifting surface, wherein the respective values of the mean-line camber of one or more of the interjacent fluid-foil sections exceed the mean-line camber of the more highly cambered tip section. It shall be understood that the preceding considerations apply to all types of lifting surfaces regardless of the respective thickness ratios of the root and tip sections. It shall also be understood that additional considerations relative to the respective thickness ratios of the various controlled fluid-foil sections are presented herein for lifting surfaces wherein the thickness ratio of the root section is the greatest, and the thickness ratio of the tip section is the smallest, respectively, of any fluid-foil section employed in the lifting surface.

Figure 2 illustrates the preferred manner in which this invention, through the employment of the aforementioned method of fluid-foil selection, achieves the establishment of a curvilinear polygon 5 describing the spanwise distribution of maximum attainable section lift coefficients, said curvilinear polygon being so shaped that it envelops closely the curve 6 describing the spanwise distribution of the actually prevailing section lift coefficients, except that beyond the spanwise point 7 at which the highest actually prevailing section lift coefficient occurs the maximum attainable section lift coefficient exceeds substantially the actually prevailing section lift coefficient, so that the stall inception occurs near midsemispan, spreads more prevalently inboardward and to a smaller extent outboardward as shown in orderly progression by curves 12, 13, 14, 15, and 16 in Figure 3, and does not involve the extreme tip of the lifting surface prior to the breakdown of the fluid flow over the entire remaining lifting surface. As used herein the curvilinear polygon 5 describing the spanwise distribution of maximum attainable section lift coefficients is established by the respective values of the maximum attainable lift coefficients of the root section 9, the tip section 8, and the third or additional control section 11, and by the respective maximum attainable lift coefficients 5 of the sections obtained by conventional fairing between each pair of controlled sections 9—11, 11—8, etc.

The curve 6 describing the spanwise distribution of the actually prevailing section lift coefficients at the maximum lift coefficient of the lifting surface is obtained by conventional methods of experimentally verified calculation for the desired lifting surface, taking into consideration the planform, effective aerodynamic washout, section lift-curve-slope characteristics, etc.

The term "envelopment" as used herein signifies the establishment of curvilinear polygon 5 on the convex side of the curve 6, wherein each individual branch 9—11, 11—8, and so forth of the curvilinear polygon 5 is tangent or nearly tangent to curve 6.

The following specification outlines the method employed in the design of the subject lifting surface of this invention, whereby to select the most opportune values of fluid-foil section mean-line camber and fluid-foil section thickness ratio required to achieve the objects of the instant invention:

To apply the subject method of this invention it is actually necessary to know only the planform of the lifting surface and the desired stall pattern. Inasmuch as practical considerations other than those pertaining solely to the control of the stalling characteristics ordinarily predetermine certain design parameters of the lifting surface, preferred embodiments of the subject method of this invention are hereinafter explained for two typical combinations of predetermined design parameters:

In the first typical configuration the following design parameters, for example, are assumed to be given a priori: (*a*) the planform of the lifting surface, based on structural and practical design considerations; (*b*) the series of fluid-foil sections to be employed, based on high-speed and other performance requirements; (*c*) the maximum permissible effective aerodynamic washout, based on drag considerations and structural bending-moment limitations; (*d*) the thickness ratio of the fluid-foil section at the root, based on the critical-Mach-Number requirements and structural weight considerations; (*e*) the thickness ratio of the fluid-foil section at the tip, based on practical space requirements for control-surface balances, etc.; (*f*) the maximum mean-line camber of any fluid-foil section on the lifting surface, based on drag and pitching-moment limitations.

The subject method of this invention is employed firstly to design the lifting surface without any effective aerodynamic washout, that is, with the three or more controlled fluid-foil sections placed at such an angle of incidence with respect to the reference chord plane of the lifting surface that the said fluid-foil sections operate at their respective zero-lift angles of attack when the entire lifting surface operates at its angle of attack for zero overall lift.

Based on fundamental experimental wind-tunnel data available for the preselected series of fluid-foil sections, graphs are plotted showing the variation in the maximum attainable section lift coefficient versus the mean-line camber, thickness ratio, and Reynolds number, respectively; similar graphs are plotted showing the variation in the section zero-lift angle of attack versus the mean-line camber, thickness ratio, and Reynolds number, respectively.

For the spanwise location of the third and additional controlled sections 2 and 11, the subject method of this invention utilizes preferably locations between the spanwise point of the highest actually prevailing section lift coefficient 7 and the spanwise point located twice as distantly from the tip 8 as point 7, with a preferable optimum at the point 17, where the tangent to the inboard portion of the curve of spanwise distribution of the actually prevailing section lift coefficients 18 intersects the horizontal tangent 19 to the same curve, as shown in Figure 4.

It will be understood, however, that inescapable practical design considerations may require that the additional controlled sections 2 and 11 be placed at spanwise stations located inside power plant nacelles or at those spanwise stations where the lifting surface is mechanically jointed for sudden changes in planform taper, or sweep-back, as is the case in craft with removable or foldable outboard panels.

The thickness ratio obtainable at the third section 11 is calculated by straight-line interpolation between the root section and the tip section or is determined by such structural or other criteria of different nature as may be considered to prevail. However, the subject method of this invention teaches that best results are achieved if the thickness ratio of the tip section 3 is smaller than the optimum section thickness ratio for absolutely maximum attainable section lift coefficient of the fluid-foil series chosen, and if the thickness ratio of the third section 2 and 11 is chosen equal to or slightly greater than the said optimum thickness ratio, so that the optimum thickness ratio occurs either at the third section 2 and 11 or at a spanwise location 21 near the point 22 of highest actually prevailing section lift coefficient.

The approximate maximum attainable lift coefficient of the entire lifting surface for appropriate values of the Reynolds number is estimated for example by dividing the maximum attainable section lift coefficient of the third fluid-foil section (obtained from the aforementioned wind-tunnel data for the selected values of the section thickness ratio and the maximum permissible mean-line camber) by the highest spanwise value of the "additional section lift coefficient

$$C_{l_{a_1}}"$$

(as defined in Army-Navy-Commerce Manual ANC-1(1) entitled "Spanwise Air-Load Distribution"), as follows:

$$C_{L_{max}} = \frac{C_{l_{max}} \text{ of interjacent section}}{C_{l_{a_1}}{}_{highest}}$$

and by repeating this operation with checks of the Reynolds number of the said most highly cambered interjacent section as specified in the co-pending application, until the maximum attainable lift coefficient of the lifting surface is accurately determined.

The spanwise distribution 6 of the actually prevailing section lift coefficients is then calculated for the maximum lift coefficient $C_{L_{max}}$ of the entire lifting surface, following one of the conventional calculation methods.

For the Reynolds number and the pre-selected thickness ratio of the tip section, the required value of the mean-line camber is determined from the graph showing the experimentally measured variation of the maximum attainable section lift coefficient with varying mean-line camber, selecting that value of the mean-line camber that produces a maximum attainable section lift coefficient 8 substantially equal to the highest actually prevailing section lift coefficient 7.

For the Reynolds number and the pre-selected thickness ratio of the root section, the required value of the mean-line camber is determined from the graph showing the experimentally measured variation of the maximum attainable section lift coefficient with varying mean-line camber, selecting that value of the mean-line camber that produces a maximum attainable section lift coefficient 9 equal to or slightly superior to the section lift coefficient 10 actually prevailing over the root section.

From the foregoing, it will be readily seen that the lifting surface obtained by the invention, and defined by the curvilinear polygon 5, embodies the combination of a fluid-foil section 1 or 9 having the smallest mean-line camber at the root, a fluid-foil section 3 or 8 having a greater mean-line camber at the tip, and one or more interjacent controlled sections 2 or 11 having values of the mean-line camber at variance with the values 4 obtainable at the respective spanwise stations by means of straight line fairing between the root section and the tip section, wherein the mean-line camber of the third or an additional interjacent controlled section exceeds the mean-line camber of the more highly cambered tip section, while avoiding the undesirable effects of any material amount of aerodynamic washin.

If, for reasons other than those pertaining solely to the control of stalling characteristics, washout is desired, a small amount of effective aerodynamic washout is introduced, ½° to 1° in each step of the application of the method, wherein the total effective aerodynamic washout is distributed in appropriate fashion between the controlled sections and where the total washout is less than the maximum permissible washout as defined in the aforesaid initial design assumptions. The entire heretofore specified procedure including the establishment of a curve 6 conforming to the washout chosen is then repeated for the selected amount of effective aerodynamic washout, until the desired results as illustrated in Figures 2 and 3 are attained while satisfying the aforesaid requirements of different nature.

A typical example of the application of the principles of this invention to one well-known type of lifting surface is as follows: Here we assume a planform taper ratio of three to one, an aspect ratio of ten, a total effective aerodynamic washout of zero degree, a section thickness ratio tapering linearly from 22 per cent at the root to 15 per cent at the tip, the utilization of "63–" series NACA "low-drag" fluid-foil sections, a mean-line camber of the most highly cambered controlled section 2 characterized by an "ideal lift coefficient" C_{l_i} equal to 0.4. The term "ideal lift coefficient" is to be interpreted as defined by the National Advisory Committee for Aeronautics nomenclature and is herein used as a parameter characteristic of the mean-line camber of a fluid-foil section. Calculations based on conventional methods will indicate that a lifting surface having the above general design parameters will experience, at its maximum resultant lift coefficient, a distribution of section lift coefficients as illustrated in curve 6.

Following the procedures hereinbefore described, we achieve in the above-outlined construction the desirable stalling characteristics taught by this invention by placing the most highly cambered controlled section at a station approximately 70 per cent of the semi-span from the root and with an effective aerodynamic washout of zero degree with respect to the root section and through the use of mean-line camber of the root section 1 characterized by an "ideal lift coefficient" C_{l_i} equal to 0.1, and a mean-line camber of the tip section 3 characterized by an "ideal lift coefficient" C_{l_i} equal to 0.35.

In this structural example the mean-line camber of the interjacent controlled section 2 is greater than that of the root section 1 and of the tip section 3, and hence greater than that of the interpolated section 4 obtainable at the 70 per cent semi-span station by means of straight-line fairing between sections 1 and 3, and which accomplishes the envelopment of curve 6 by the curvilinear polygon 5.

It will be fully appreciated by those skilled in this art that the invention may be readily embodied in various devices wherein the thickness ratio of the interjacent section 2 is varied from that obtainable through straight-line fairing between root section 1 and tip section 3 in order to facilitate the attainment of the objectives of this invention with the smallest possible range of values of section mean-line camber.

The second typical configuration differs from the first in that two interjacent sections 2 may be utilized. Hence, the following design parameters are assumed to be given a priori: (*a*) The plan form of the lifting surface; (*b*) the series of fluid-foil sections to be employed and their fluid-dynamic characteristics; (*c*) the maximum permissible effective aerodynamic washout; (*d*) the thickness ratios of the fluid-foil section at the root and of the fluid-foil section at the tip, respectively; (*e*) the maximum mean-line camber to be assigned to any fluid-foil section on the lifting surface.

The number of interjacent "controlled" fluid-foil sections, in this case, is not limited. The following representative specification applies to the case of two interjacent controlled fluid-foil sections; however, the reasonings specified therein are obviously usable in the design of lifting surfaces with a different number of interjacent controlled sections. Here it will be understood that the values of the mean-line camber of one or more of the interjacent controlled sections 2 are greater than that of the more highly cambered tip section 3, while one or more of the remaining interjacent controlled sections 2 may be either greater or smaller than that of the aforementioned tip section 3, depending on the range of section thickness ratios encountered between the root and the tip of the lifting surface.

In this case the instant method teaches that the optimum spanwise location for the interjacent fluid-foil section having the greatest mean-line camber is in the vicinity of the spanwise station carrying the highest actually prevailing section lift coefficient 7, and that the optimum spanwise location for the second interjacent fluid-foil section is point 17, where the tangent at the root to the curve of spanwise distribution of the actually prevailing section lift coefficients 18 intersects the horizontal tangent 19 to the same curve, as shown in Figure 4. The instant method also teaches that best stalling characteristics are obtained by assigning to the two or more interjacent fluid-foil sections values of the section thickness ratio that, for the series of fluid-foil sections selected, yield the absolutely maximum attainable section lift coefficients.

The approximate maximum attainable lift coefficient of the entire lifting surface is estimated by dividing the maximum attainable section lift coefficient of the most highly cambered fluid-foil section by the highest spanwise value of the "additional section lift coefficient

$$C_{l_{a_1}}"$$

in a manner substantially similar to that previously outlined.

The spanwise distribution of the actually prevailing section lift coefficients 23 is then calculated for the maximum lift coefficient of the entire lifting surface as previously outlined.

For the Reynolds number of the additional interjacent fluid-foil section, preferably located at the spanwise station 17 abovedefined, the required value of the mean-line camber and if necessary the thickness ratio is determined substantially as outlined for the fluid-foil section 11 in the co-pending application.

The value of the mean-line camber of the fluid-foil section located at the tip of the lifting surface is not of consequence in the application of the subject method of this invention, provided that the maximum attainable section lift coefficients represented by the curved segment connecting points 22 and 20 Figure 5 remains substantially above the curve of actually prevailing section lift coefficients 23.

If the designer intends to achieve positive stall inception in a certain spanwise panel of the lifting surface, the subject method of this invention specifies that in either of the aforedescribed design procedures the mean-line camber and thickness ratios, as well as the spanwise location, of the sections comprised within or adjacent to the panel for which stall inception is desired be so selected that within the "stall inception panel" the curve of maximum attainable section lift coefficients lies slightly below the curve of actually prevailing section lift coefficients, without modifying the aforedescribed relationship of the maximum attainable section lift coefficients and the actually prevailing section lift coefficients on the remainder of the semispan of the lifting surface outside of the "stall-inception panel" proper.

If, in any of the aforedescribed cases, the lifting surface under consideration is modified by excrescences such as, for example, power-plant nacelles, or flaps that modify the local zero-lift angle and the local maximum attainable section lift coefficient, the calculation of the maximum attainable section lift coefficients and of the effective washout at the various spanwise stations takes due account of the effects of these modifications by introducing "equivalent values" of the effective washout and section mean-line camber into the subject method of this invention.

Upon completion of the procedure outlined for the subject method of this invention, the zero-lift angles of the fluid-foil sections selected thusly are determined for their respective mean-line cambers, thickness ratios, and Reynolds numbers, and each fluid-foil section is set properly with respect to the reference chord plane of the lifting surface, so that the desired effective washout is achieved.

By practicing my invention a lifting surface can be designed and constructed to achieve the objects hereinbefore stated.

Theoretical calculations, as well as numerous tests performed in flight and in the laboratory, have demonstrated convincingly that each of the objects of this invention has been fully achieved.

The inventor wishes it to be clearly understood that the generally judged excellently satisfactory stalling characteristics of lifting surfaces designed and constructed according to the subject method of this invention are directly attributable to the use of three (or more) controlled fluid-foil sections selected according to the hereinbefore specified method of this invention, and to the aforedescribed method employed in the design of such lifting surfaces.

This invention accomplishes an important improvement in the art, and the discoveries herein disclosed are of great value to all types of aircraft (as well as to craft operating in other fluids), throughout their entire operating range, and especially in the critical low-speed operation where steadiness of lift and lift variation, stability of the craft, control effectiveness, and smoothness and stability of control forces are of vital importance for the safety and efficiency of the craft; also in violent maneuvers at high speeds when high lifting-surface lift coefficients comparable with those occurring at the low-speed stall are encountered and even temporarily surpassed.

I claim:

1. A lifting surface with three or more controlled fluid-foil sections, in which the first sec-

tion with a small mean-line camber is located at the root, the second section with greater mean-line camber is located at the fluid-dynamically effective tip, and the third or additional fluid-foil sections are located at stations interjacent between the root and the tip, wherein the values of the mean-line camber of the interjacent fluid-foil sections are at variance with the values of the mean-line camber obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section, said three or more controlled fluid-foil sections having values of the mean-line camber selected in such manner that the resulting spanwise distribution of maximum attainable section lift coefficients of the three or more controlled sections forms a curvilinear polygon enveloping a curve representing the spanwise distribution of section lift coefficients prevailing at the maximum attainable lift coefficient of the lifting surface, for a given planform and discarding the effect of any material amount of aerodynamic washin.

2. A lifting surface with three or more controlled fluid-foil sections adapted to provide stall inception within a predetermined interval of spanwise stations, in which the first section with a small mean-line camber is located at the root, the second section with greater mean-line camber is located at the fluid-dynamically effective tip, and the third or additional fluid-foil sections are located at stations interjacent between the root and the tip, wherein the values of the mean-line camber of the interjacent fluid-foil sections are at variance with the values of the mean-line camber obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section, said three or more controlled fluid-foil sections having values of the mean-line camber selected in such manner that the resulting spanwise distribution of maximum attainable section lift coefficients of the three or more controlled sections forms a curvilinear polygon enveloping a curve representing the spanwise distribution of section lift coefficients prevailing at the maximum attainable lift coefficient of the lifting surface, for a given planform and discarding the effect of any material amount of aerodynamic washin, and that the said polygon representing the resulting spanwise distribution of maximum attainable section lift coefficients be so shaped that the first intersection with the curve representing the spanwise distribution of prevailing section lift coefficients occurs in that interval of spanwise stations for which stall inception is to be obtained.

3. A lifting surface with three or more controlled fluid-foil sections, in which the first section with a small mean-line camber and greatest thickness ratio is located at the root, the second section with greater mean-line camber and smallest thickness ratio is located at the fluid-dynamically effective tip, and the third or additional fluid-foil sections are located at stations interjacent between the root and the tip, wherein the values of the thickness ratio of the interjacent fluid-foil sections are greater than the values of the thickness ratio obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section.

4. A lifting surface with three or more controlled fluid-foil sections, in which the first section with a small mean-line camber is located at the root, the second section with greater mean-line camber is located at the fluid-dynamically effective tip and the third or additional fluid-foil sections are located at stations interjacent between the root and the tip, wherein the values of the thickness ratio of the interjacent fluid-foil sections are at variance with the values of the thickness ratio obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section, said three or more controlled fluid-foil sections having values of the mean-line camber and the thickness ratio selected in such manner that the resulting spanwise distribution of maximum attainable section lift coefficients of the three or more controlled sections forms a curvilinear polygon enveloping a curve representing the spanwise distribution of section lift coefficients prevailing at the maximum attainable lift coefficient of the lifting surface, for a given planform and discarding the effect of any material amount of aerodynamic washin.

5. A lifting surface with three or more controlled fluid-foil sections adapted to provide stall inception within a predetermined interval of spanwise stations, in which the first section with a small mean-line camber is located at the root, the second section with greater mean-line camber is located at the fluid-dynamically effective tip, and the third or additional fluid-foil sections are located at stations interjacent between the root and the tip, wherein the values of the thickness ratio of the interjacent fluid-foil sections are at variance with the values of the thickness ratio obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section, said three or more controlled fluid-foil sections having values of the mean-line camber and the thickness ratio selected in such manner that the resulting spanwise distribution of maximum attainable section lift coefficients of the three or more controlled sections forms a curvilinear polygon enveloping a curve representing the spanwise distribution of section lift coefficients prevailing at the maximum attainable lift coefficient of the lifting surface, for a given planform and discarding the effect of any material amount of aerodynamic washin, and that the said resulting spanwise distribution of maximum attainable section lift coefficients be so shaped that the first

intersection with the spanwise distribution of prevailing section lift coefficients occurs in that interval of spanwise stations for which stall inception is to be obtained.

6. A lifting surface with three or more controlled fluid-foil sections, and having a highest actually prevailing section lift coefficient at a predetermined spanwise station, in which the first section with a small mean-line camber is located at the root, the second section with greater mean-line camber is located at the fluid-dynamically effective tip, and one of the interjacent fluid-foil sections is located near a spanwise point where a tangent to the inboard portion of the curve representing the spanwise distribution of actually prevailing section lift coefficients, for a given planform and discarding the effect of any material amount of aerodynamic washin, intersects a substantially horizontal tangent to the highest point of the same curve, wherein the values of the mean-line camber of the interjacent fluid-foil sections are greater than the values of the mean-line camber obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section.

7. A lifting surface with three or more controlled fluid-foil sections, and having a highest actually prevailing section lift coefficient at a predetermined spanwise station, in which the first section with a small mean-line camber and greatest thickness ratio is located at the root, the second section with greater mean-line camber and smallest thickness ratio is located at the fluid-dynamically effective tip, and one of the interjacent fluid-foil sections is located near a spanwise point where a tangent to the inboard portion of a curve representing the spanwise distribution of actually prevailing section life coefficients, for a given planform, and discarding the effect of any material amount of aerodynamic washin, intersects a substantially horizontal tangent to the highest point of the same curve, wherein the values of the thickness ratio of the interjacent fluid-foil sections are greater than the values of the thickness ratio obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section.

8. A lifting surface with three or more controlled fluid-foil sections, and having a highest actually prevailing section lift coefficient at a predetermined spanwise station. in which the first section with a small mean-line camber is located at the root, the second section with greater mean-line camber is located at the fluid-dynamically effective tip. and two of the interjacent fluid-foil sections are located respectively near the spanwise station of highest actually prevailing section lift coefficient and near a spanwise point where a tangent to the inboard portion of a curve representing the spanwise distribution of actually prevailing section lift coefficients, for a given planform and discarding the effect of any material amount of aerodynamic washin, intersects the horizontal tangent to the highest point of a substantially same curve, wherein the values of the mean-line camber of the interjacent fluid-foil sections are greater than the values of the mean-line camber obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section.

9. A lifting surface with three or more controlled fluid-foil sections, and having a highest actually prevailing section lift coefficient at a predetermined spanwise station, in which the first section with a small mean-line camber and greatest thickness ratio is located at the root, the second section with greater mean-line camber is located at the fluid-dynamically effective tip, and two of the interjacent fluid-foil sections are located respectively near the spanwise station of highest actually prevailing section lift coefficient and near a spanwise point where a tangent to the inboard portion of a curve representing the spanwise distribution of actually prevailing section lift coefficients, for a given planform and discarding the effect of any material amount of aerodynamic washin, intersects a substantially horizontal tangent to the highest point of the same curve, wherein the values of the thickness ratio of the interjacent fluid-foil sections are greater than the values of the thickness ratio obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section.

10. A lifting surface with three or more controlled fluid-foil sections, in which the first section with a small mean-line camber and greatest thickness ratio is located at the root, the second section with greater mean-line camber and smallest thickness ratio is located at the fluid-dynamically effective tip, and the third or additional fluid-foil sections are located at stations interjacent between the root and the tip, wherein the values of the thickness ratio of the interjacent fluid-foil sections are smaller than the values of the thickness ratio obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section.

11. A lifting surface with three or more controlled fluid-foil sections, and having a highest actually prevailing section lift coefficient at a predetermined spanwise station, in which the first section with a small mean-line camber and greatest thickness ratio is located at the root, the second section with greater mean-line camber and smallest thickness ratio is located at the fluid-dynamically effective tip, and one of the interjacent fluid-foil sections is located near a spanwise point where a tangent to the inboard portion of a curve representing the spanwise distribution of actually prevailing section lift co-

efficients, for a given planform and discarding the effect of any material amount of aerodynamic washin, intersects a substantially horizontal tangent to the highest point of the same curve, wherein the values of the thickness ratio of the interjacent fluid-foil sections are smaller than the values of the thickness ratio obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section.

12. A lifting surface with three or more controlled fluid-foil sections, and having a highest actually prevailing section lift coefficient at a predetermined spanwise station, in which the first section with a small mean-line camber and greatest thickness ratio is located at the root, the second section with greater mean-line camber and smallest thickness ratio is located at the fluid-dynamically effective tip, and two of the interjacent fluid-foil sections are located respectively near the spanwise station of highest actually prevailing section lift coefficient and near a spanwise point where a tangent to the inboard portion of a curve representing the spanwise dis-

tribution of actually prevailing section lift coefficients, for a given planform and discarding the effect of any material amount of aerodynamic washin, intersects a substantially horizontal tangent to the highest point of the same curve, wherein the values of the thickness ratio of the interjacent fluid-foil sections are smaller than the values of the thickness ratio obtainable at the respective spanwise stations by means of straight-line fairing between the fluid-foil section located at the root of the lifting surface and the fluid-foil section located at the tip of the lifting surface, and wherein the mean-line camber of one or more of the interjacent fluid-foil sections exceeds the mean-line camber of the more highly cambered tip section.

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